JOHN F. KENNEDY SPACE CENTER

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SATURN V ELECTRICAL GROUND SUPPORT EQUIPMENT FOR LAUNCH COMPLEX 39

LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION

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TECHNICAL STAFF
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION

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SECTION I
INTRODUCTION

1-1. PURPOSE

The purpose of this document is to present, locate, and describe all electrical ground support equipment, so far as presently defined, which comes under the design cognizance of the Launch Support Equipment Engineering Division for Launch Complex 39.

1-2. SCOPE

This document is limited to a description of the Electrical Ground Support Equipment (EGSE) provided by or under the design cognizance of the Launch Support Equipment Engineering Division for Launch Complex 39, Merritt Island Launch Area, Kennedy Space Center, Florida. The design of much of the equipment described herein is not yet complete. This document therefore will be revised to reflect changes and modifications as they occur. In broad terms, however, the function and purpose of the systems and equipment described is expected to endure. This following is included in this document:

a. Propellants Branch (DP). Responsible for the design of the Liquid Oxygen (LOX), Liquid Hydrogen (LH_2) and RP-1 propellant storage facilities and propellant transfer systems, the Environmental Control System, and the High Pressure Gases Facilities which include the Converter Compressor Facility and the High Pressure Gases Distribution System up to the point of interface at the Launcher Umbilical Tower (LUT).

b. Launch Equipment Branch (DE). Responsible for the design of the Swing Arms and the LUT Electrical Support Equipment (ESE) which comprise mainly those systems which control, test, and monitor the service arms, command module access arm, tail service masts, pneumatic distribution systems, hydraulic supply systems, and the servicing platforms.

c. Launcher/Transporter Systems Branch (DL). Responsible for the design of the Launcher Umbilical Tower, the Crawler/Transporter, the Flame Deflector, and all the integral facility type systems pertinent to the LUT and the Crawler/Transporter.

1-3. LAUNCH COMPLEX 39

Launch Complex 39 (figures 1-1 and 1-2), located within the Merritt Island Launch Area of Kennedy Space Center, provides the facilities and equipment

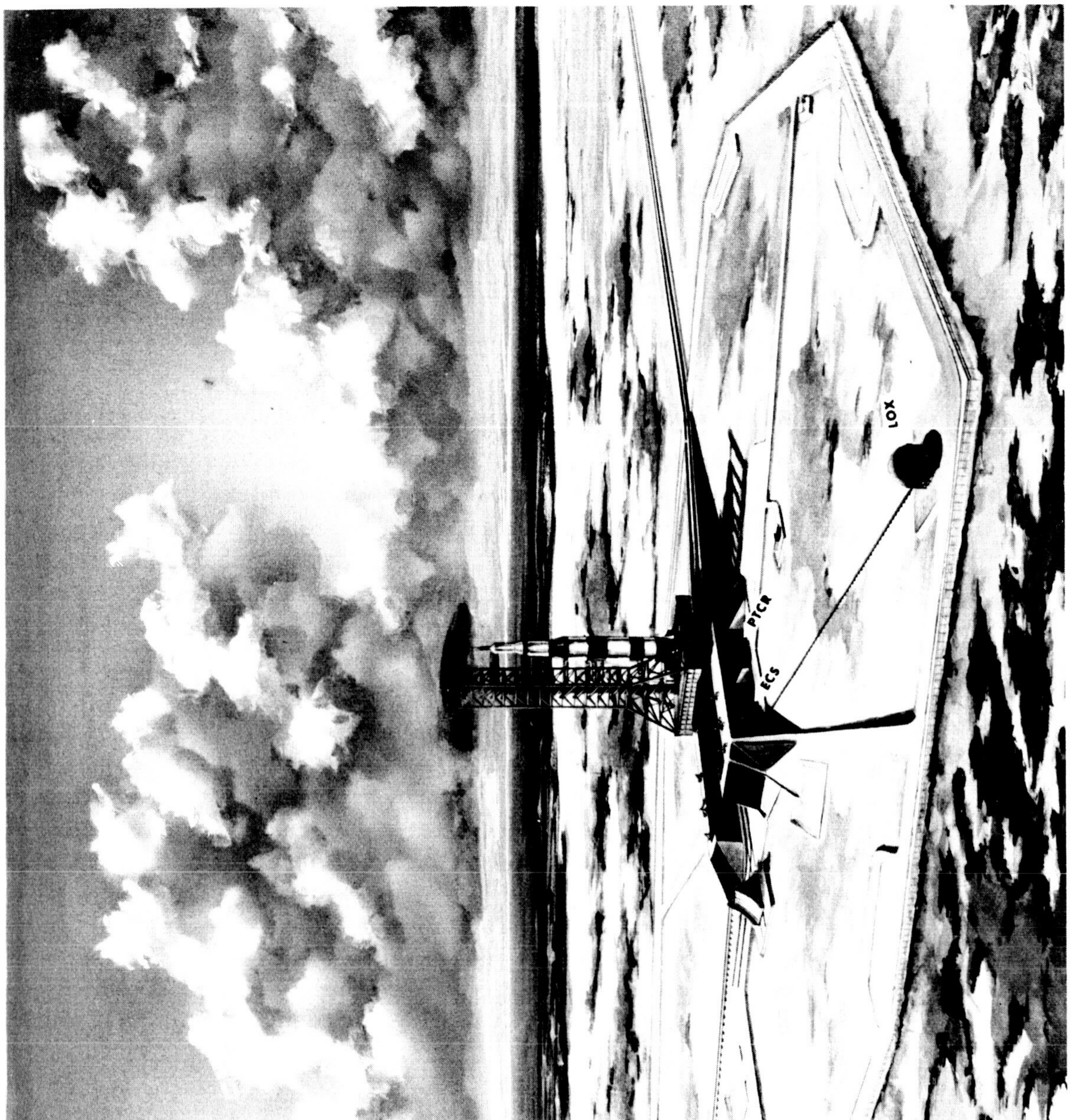


Figure 1-1. Launch Complex 39

Figure 1-2. Typical Saturn V Pad

necessary to receive, assemble, checkout, and launch Saturn V vehicles with their payloads, Complex 39 consists of the following major categories of facilities or equipment.

a. Launcher Umbilical Tower (LUT)
b. Arming Tower
c. Crawler/Transporter
d. Crawlerway
e. Vertical Assembly Building (VAB)
f. Launch Control Center (LCC)
g. Launch Pad Areas
h. Propellant Facilities
i. High Pressure Gas Facilities
j. Ordnance Storage Facilities

The complex is designed for the mobile operational concept. Under this concept, the vehicle is assembled and checked out on a LUT positioned in one of the high bays of the VAB. The LUT, with the assembled vehicle, is then moved by the Crawler/Transporter along the Crawlerway to one of the launch pad areas. Major ordnance items are installed at the VAB.

Assembled vehicle checkout and launch activity in the VAB and pad area are accomplished by the use of automatic checkout equipment located in one of the firing rooms of the LCC. An overall Saturn V flow sequence is shown in figure 1-3.

1-4. ELECTRICAL SYSTEMS

Figure 1-4 is a block layout of LC-39 electrical systems and interfaces. Figure 1-5 shows the rack locations and layouts. The functions of these systems are described in succeeding sections. A physical description of the equipment follows.

1-5. LAUNCH PAD ELECTRICAL SYSTEMS

1-6. Pad Terminal Connection Room. The PTCR contains the following Launch Support Equipment Engineering Division electrical equipment (equipment functions are described in a subsequent section of this document under the Data Transmission System description and the Propellant Loading System description):

a. Four (4) racks which contain the propellants systems D-C power equipment. The rack layout is given in figure 1-6.

b. Eight (8) racks which contain the Data Transmission System equipment. The DTS rack layout is given in figure 1-7.

c. Five (5) Propellant Systems racks which contain timer panels, D-C power distributors, and patch racks. The rack layout for this equipment is given in figure 1-8.

VEHICLE STAGE / ON DOCK

- S-IC — BARGE/W TRANSPORTER
- S-II — LSD/W TRANSPORTER
- S-IVB — BARGE/SHIP/W TRANSPORTER
- RAIL, ROAD, BARGE, AIR DELIVERED IN 3 SEGMENTS
- APOLLO SPACECRAFT — AIRCRAFT
- ORDNANCE

VAB LOW BAY

S-II

1. VISUAL INSPECTION
   a. ENGINE PROTECTION COVER REMOVED
   b. STAGE ACCESSIBLE COMPONENTS AND SYSTEM INSPECTED
2. MATE S-II AFT INTERSTAGE (PARTIAL)
3. ERECTION C/O DOLLY
4. COMPLETE SEPARATION JOINT (ALL TENSION STRAPS)
5. INSTALLATION OF ITEMS REMOVED FOR SHIPMENT
6. ELECTRICAL AND MECHANICAL MATING OF GSE
7. CONTINUITY CHECKS
8. INSTRUMENTATION CHECKOUT AND CALIBRATION
9. MECHANICAL COMPONENT FUNCTIONAL TESTING
10. TANKAGE LEAK CHECKS (50% MAX. PRESS.)
11. PNEUMATICS AND HYDRAULIC SYSTEM LEAK CHECKS
12. DISCONNECT GSE
13. RETRACT WORK PLATFORMS
14. MOVE TO LOW BAY AISLE
15. MOVE TO HIGH BAY AISLE
16. CONNECT 175-TON BRIDGE CRANE
17. S-II STAGE TRANSFERRED TO APPROPRIATE HIGH BAY
18. DISCONNECT 175-TON CRANE AND HOOK UP 250-TON CRANE
19. ERECT S-II STAGE

S-IVB

1. VISUAL INSPECTION
   a. REMOVE ENGINE PROTECTIVE COVER
   b. STAGE ACCESSIBLE COMPONENTS AND SYSTEMS INSPECTED
2. ERECTION ON C/O DOLLY
3. INSTALLATION OF ITEMS REMOVED FOR SHIPMENT
4. ELECTRICAL AND MECHANICAL MATING OF GSE
5. CONTINUITY CHECKS
6. INSTRUMENTATION CHECKOUT AND CALIBRATION
7. MECHANICAL COMPONENT FUNCTIONAL TESTING
8. TANKAGE LEAK CHECKS
9. PNEUMATICS AND HYDRAULIC SYSTEM LEAK CHECKS
10. DISCONNECT GSE
11. REMOVE WORK PLATFORMS
12. MOVE S-IVB TO LOW BAY AISLE
13. S-IVB AFT INTERSTAGE INSTALLED
14. S-IVB LOWERED ON TRANSFER DOLLY
15. DISCONNECT 175-TON CRANE AND HOOKUP 250-TON CRANE
16. ERECT S-IVB STAGE

Instrument Unit

1. INSPECTION
2. ASSEMBLY

SPACECRAFT OPERATIONS AND CHECKOUT BUILDING

1. VISUAL INSPECTION
2. ACCESSIBLE COMPONENTS AND SYSTEMS INSPECTED
3. INSTALLATION OF ITEMS REMOVED FOR SHIPMENT
4. COMPONENT AND SYSTEM TEST (SPACECRAFT)
5. MODULE STATIC TESTS
6. LEM C/O
7. ASSEMBLE CM/SM AND VERIFY AS A UNIT
8. TRANSPORT IN VERTICAL ATTITUDE TO VAB

ORDNANCE STORAGE AREA

1. STORE ORDNANCE ITEMS
   a. CONTAINED DETONATING FUSES
   b. CHEVRON MILD DETONATING FUSES
   c. FLEXIBLE SHAPE CHARGES
   d. EBW DETONATORS
   e. RETRO ROCKETS
   f. ULLAGE ROCKETS
   g. APOLLO SEPARATION AND DESTRUCT ORDNANCE
   h. APOLLO LAUNCH ESCAPE SYSTEM (LES)
   i. FIRING UNIT TEST SETS

VAB HIGH BAY

1. VISUAL INSPECTION
   a. F-1 ENGINE COVERS REMOVED
   b. STAGE ACCESSIBLE COMPONENTS AND SYSTEMS INSPECTED FOR DAMAGE
2. ERECTION ON L-UT
   a. L-UT IN POSITION & LEVELED
   b. HOLD DOWN ARMS LEVELED
   c. ENGINE SERVICE PLATFORM IN PLACE
   d. L-UT VAB SERVICES CONNECTED
3. ENGINE SHROUDS INSTALLED
4. INSTALL FINS
5. STAGE VERTICAL ALIGNMENT CHECK
6. CONNECT FIRING ACCESSORIES
   a. TAIL SERVICE MASTS
   b. INTERTANK UMBILICAL
   c. FORWARD UMBILICAL
   d. C/O EQUIPMENT CONNECTED (ELECTRICAL AND MECHANICAL)
   e. ADJUSTABLE WORK PLATFORMS POSITIONED
7. L-UT ELECTRICAL GSE CONNECTED TO LCC VIA HIGH SPEED DATA LINK
8. CHECK COMPONENTS
9. INITIAL CHECKS
   a. COMPONENT LEVEL
   b. SUB-SYSTEM
10. MATE S-II TO S-IC STAGE
11. MATE S-IVB TO S-II FORWARD INTERSTAGE
12. MATE I.U. TO S-IVB FORWARD INTERSTAGE
13. ALIGNMENT CHECK OF ALL STAGES WITH L-UT MOUNTED THEODOLITES
14. ORDNANCE ITEMS INSTALLED (CLASS 12)
    a. S-IC MDF INSTALLED AT FACTORY OR MTF (2 GRAINS/FT.)
    b. S-IVB MDF
    c. S-II TO S-IVB SEPARATION CHARGE (DUAL CIRCUMFERENTIAL MDF, 5 TO 10 GRAINS PER FOOT)
    d. S-II AND S-IVB CDF (RETRO FIRING)
    e. EBW FIRING UNITS & SAFE AND ARM DEVICES
15. CONNECT UMBILICAL SWING ARMS
16. STAGE-GSE COMPATIBILITY TESTS
    a. LIMITED STAGE - GSE CHECKS W/EACH STAGE PRIOR TO ELECTRICALLY MATING STAGES WITH EACH OTHER
17. ALL STAGES ELECTRICALLY MATED
18. LAUNCH VEHICLE SYSTEMS TESTS
    a. CONTROL SYSTEMS TEST
    b. ORDNANCE SYSTEMS TEST
    c. RF SYSTEMS TEST
19. OVERALL LAUNCH VEHICLES SYSTEMS TEST
20. ASSEMBLY OF SATURN V/APOLLO SPACE VEHICLE
21. ALIGNMENT CHECKS OF ENTIRE SATURN V/APOLLO SPACE VEHICLE
22. CONNECT SPACECRAFT UMBILICALS
23. POSITION VAB PLATFORM (SPACECRAFT)
24. INTERFACES AND COMPATIBILITY TESTS
    a. ELECTRICAL GROUND SUPPORT EQUIPMENT INTERFACE (GSE)
    b. AIRBORNE INTERFACE
    c. ABORT AND EMERGENCY DETECTION
    d. R. F. SYSTEMS AND COMPUTER INTERFACES
25. COMBINED SPACECRAFT AND LAUNCH VEHICLE SYSTEMS TEST
    a. UMBILICAL EJECT AND RETRACT
    b. FIRE LIVE ORDNANCE IN TEST CHAMBERS
    c. INTERNAL POWER ON BATTERIES (FLIGHT TYPE)
    d. ELECTRICAL DISCONNECT OF STAGES DURING SEQUENCE RUNS
    e. ALL POSSIBLE ACTIVE FLIGHT SYSTEMS
26. SIMULATED FLIGHT TEST
    a. ALL SYSTEMS TEST
    b. APPROPRIATE COUNT DOWN AND SIMULATED FLIGHT FUNCTIONS
27. ORDNANCE INSTALLATION
    a. STAGE ORDNANCE
       (1) S-IC
          (a) LOX TANK
          (b) RP-1 TANK
       (2) S-II
          (a) LH_2 TANK
          (b) LOX TANK
          (c) S-IC/S-II STAGE SEPARATION
       (3) S-IVB
          (a) LH_2 TANK
          (b) LOX TANK
    b. RETRO AND ULLAGE ROCKETS
       (1) S-IC STAGE
          (a) RETRO - 2 EACH IN PAIRS LOCATED IN ENGINE SHROUDS
       (2) S-II STAGE
          (a) ULLAGE ROCKETS
             8 LOCATED SINGLY ABOUT S-II AFT INTERSTAGE
          (b) RETROS
             4 EACH LOCATED IN PAIRS ON S-IVB AFT INTERSTAGE
       (3) S-IVB
          (a) RETROS
             2 EACH LOCATED ON FORWARD INTERSTAGE
    c. APOLLO SPACECRAFT
       (1) LAUNCH ESCAPE SYSTEM (LES)
28. PREPARED VEHICLE FOR PAD TRANSIT
    a. DISCONNECT PNEUMATIC, HYDRAULIC, AND ELECTRICAL INTERFACE LINES FROM L-UT TO VAB
    b. RETRACT WORK PLATFORMS

LAUNCH PAD PREPARATION

PRIOR TO TRANSFER OF SPACE VEHICLE TO PAD

1. C/O PERMANENT TYPE PAD GSE (GETS)
2. INTERFACE CHECKS OF PAD GSE AND L-UT FROM A LOCAL CHECKOUT STATION
3. CONNECT DATA LINK TO LCC AND REMOTE C/O OF PAD GSE PERFORMED WITH SIMULATORS

LAUNCH PAD

1. POSITION L-UT VIA CRAWLER INTO POSITION AT PAD AND LOWER L-UT ON STEEL PEDESTALS
2. LOCK L-UT TO PEDESTALS
   a. INSTALL FOUR (4) DYNAMIC SUPPORT PEDESTALS
3. CONNECT LUT/SPACE VEHICLE SERVICES
   a. DIGITAL DATA LINK
   b. COMMUNICATION CIRCUITRY
   c. PNEUMATIC SUPPLY LINES
   d. PROPELLANT LINES
   e. ENVIRONMENTAL CONTROL
   f. ELECTRICAL POWER SUPPLY LINES
   g. F-1 ENGINE SERVICING PLATFORMS
   h. CONNECT WATER COOLING AND FLUSHING LINES
4. VEHICLE VERTICAL ALIGNMENT CHECK
5. STABILIZE PLATFORM ALIGNMENT
6. POSITION ARMING TOWER ON PEDESTALS
7. LAUNCH PAD PROGRAM
   a. LIMITED SUB-SYSTEM VERIFICATION CHECKS FROM LCC
   b. CHECKOUT OF HARDWIRE BACKUP CIRCUITS TO LCC
   c. TANK PRESSURIZATION TEST (FLIGHT PRESSURE)
   d. PROPELLANT LOADING TEST
   e. RF TESTS
   f. ABORT SYSTEM TEST
   g. SIMULATED FLIGHT TEST - SIMULATED COMPLETE LAUNCH DAY COUNT DOWN, LAUNCH, AND FLIGHT OPERATIONS. COMPATIBILITY WITH RANGE AND INTEGRATED MISSION CONTROL CENTER IS VERIFIED.
8. COUNT DOWN PHASE
   a. ORDNANCE CONNECTED
   b. RP-1 LOADED L-1 DAY 215 MIN (2000 GPM & 200 GPM)
   c. PROPELLANT LOADING OF APOLLO SPACECRAFT (LAUNCH DAY)
   d. HYPERGOLIC LOADED IN S-IVB AUXILIARY PROPULSION SYSTEM
   e. MOVE ARMING TOWER TO PARK POSITION
   f. T-7 HOURS
      (1) LOX S-IVB STAGE - 32 MINUTES @ 1000 GPM
      (2) LOX S-II STAGE - 25 MINUTES @ 5000 GPM
      (3) LOX S-IC STAGE - 40 MINUTES @ 10,000 GPM
      (4) LH_2 S-IVB STAGE - 35 MINUTES @ 3000 GPM
      (5) LH_2 S-II STAGE - 35 MINUTES @ 10,000 GPM
   g. T-4 HOURS
      (1) ASTRONAUT EMBARKATION VIA L-UT INGRESS - TIME REQUIRED APPROXIMATELY 135 MINUTES
   h. T-105 MINUTES
      (1) FINAL SYSTEM CHECKS CONDUCTED
   i. T + 5.9 SEC LIFT OFF

Figure 1-3. Saturn V Flow Sequence

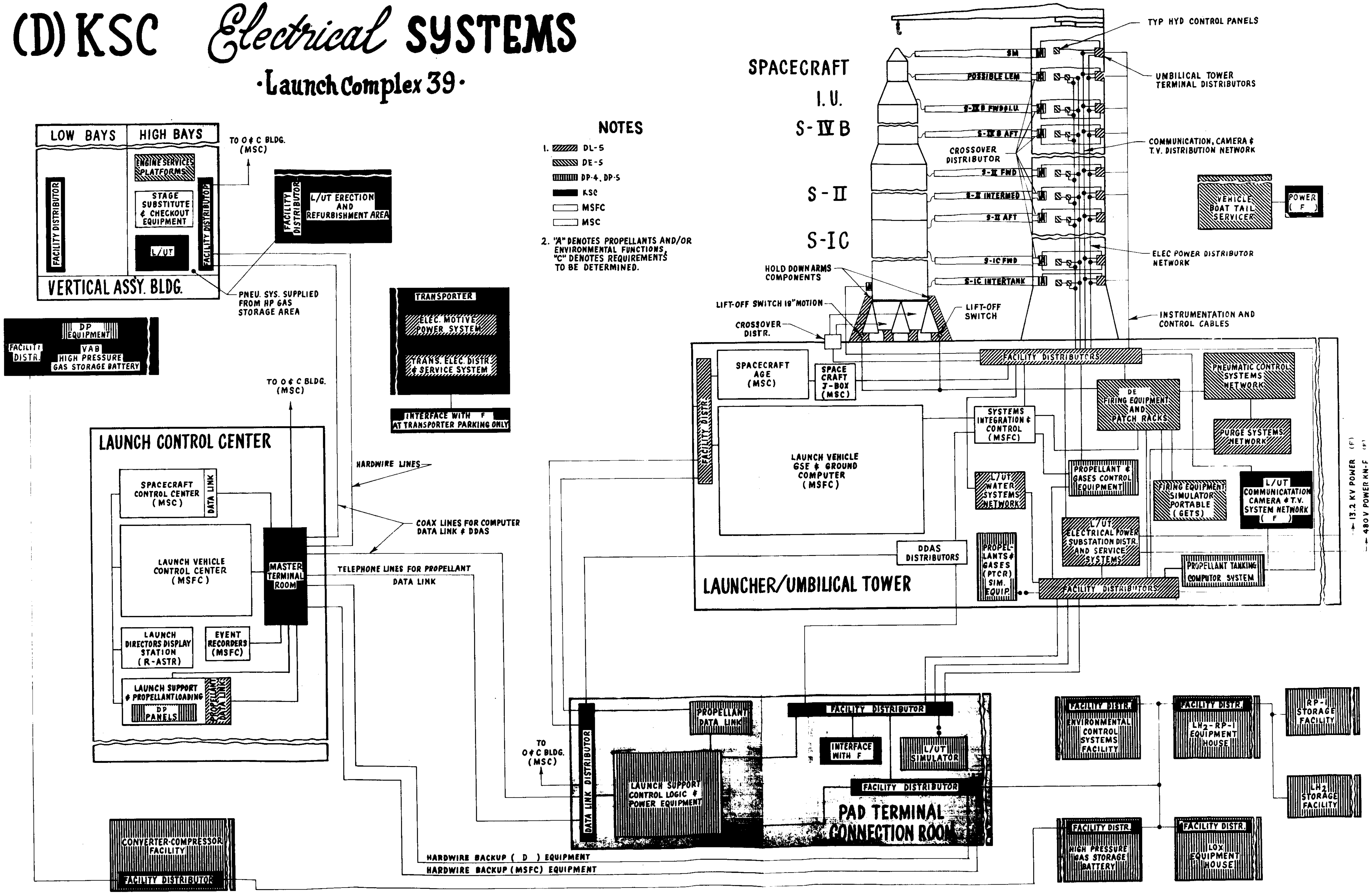


Figure 1-4. LC-39 Electrical Systems and Interfaces

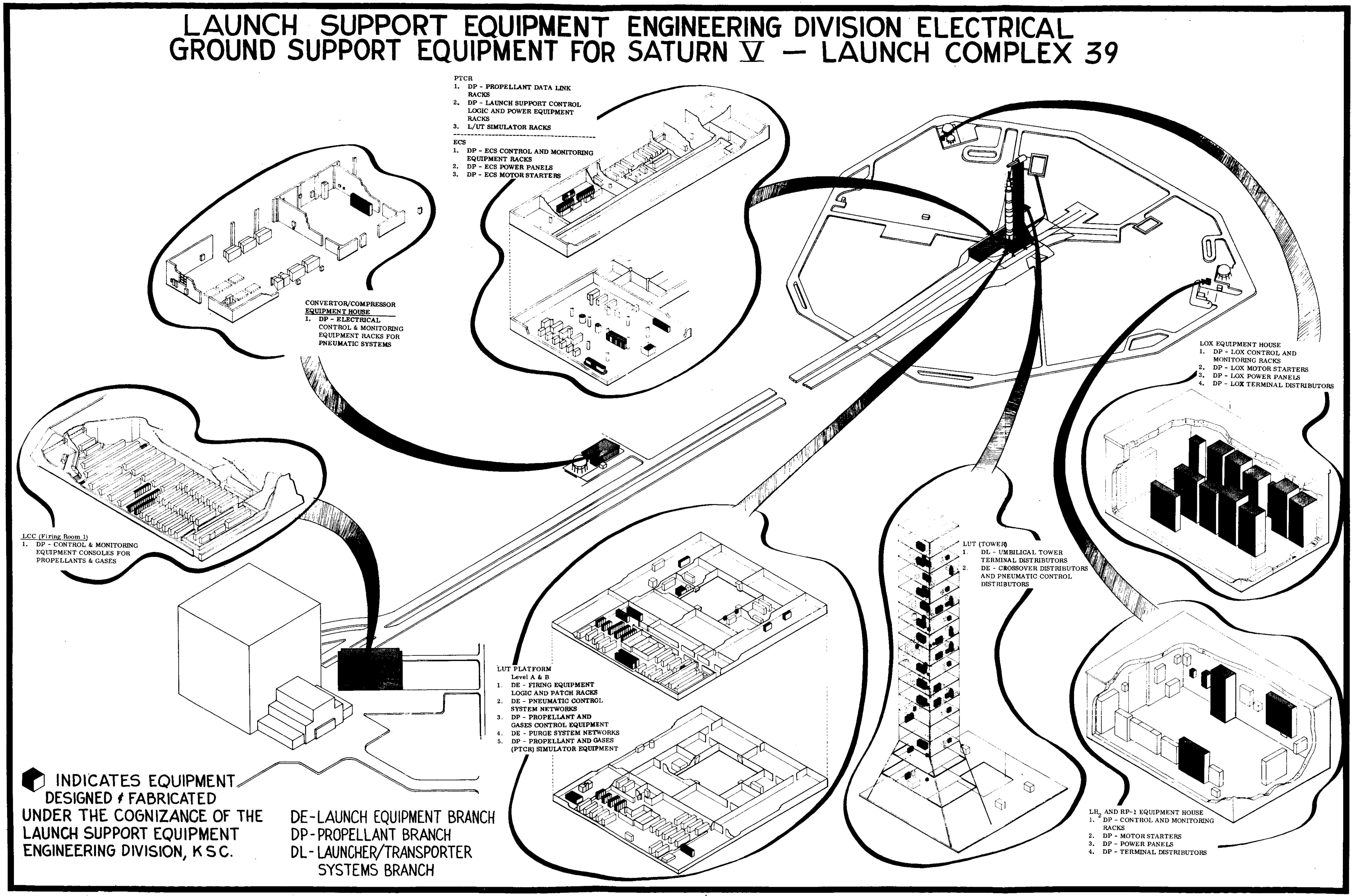


Figure 1-5. LC-39 Electrical Ground Support Equipment Rack Locations and Layo

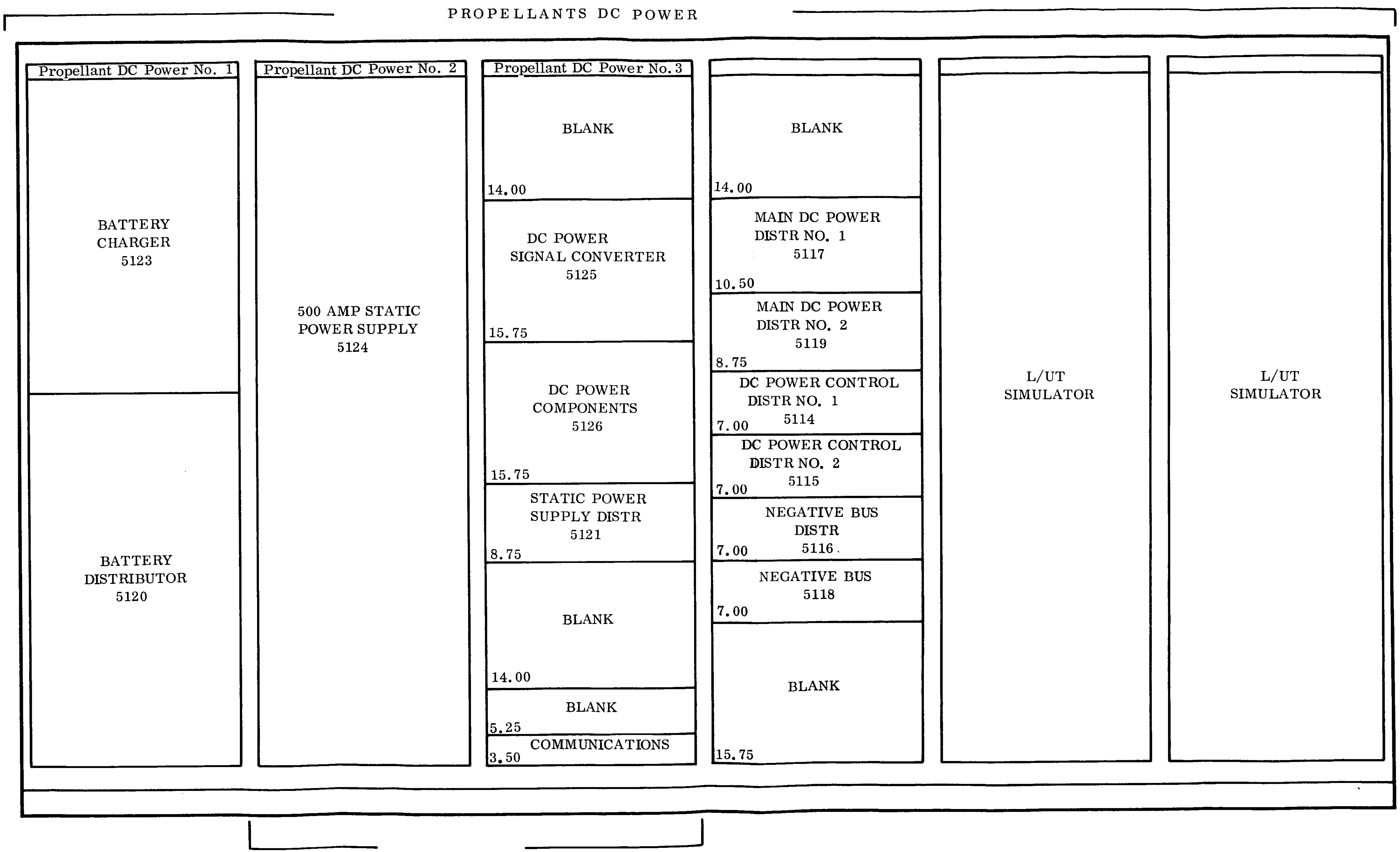


Figure 1-6. Propellants Systems Power Equipment (Rack Layout)

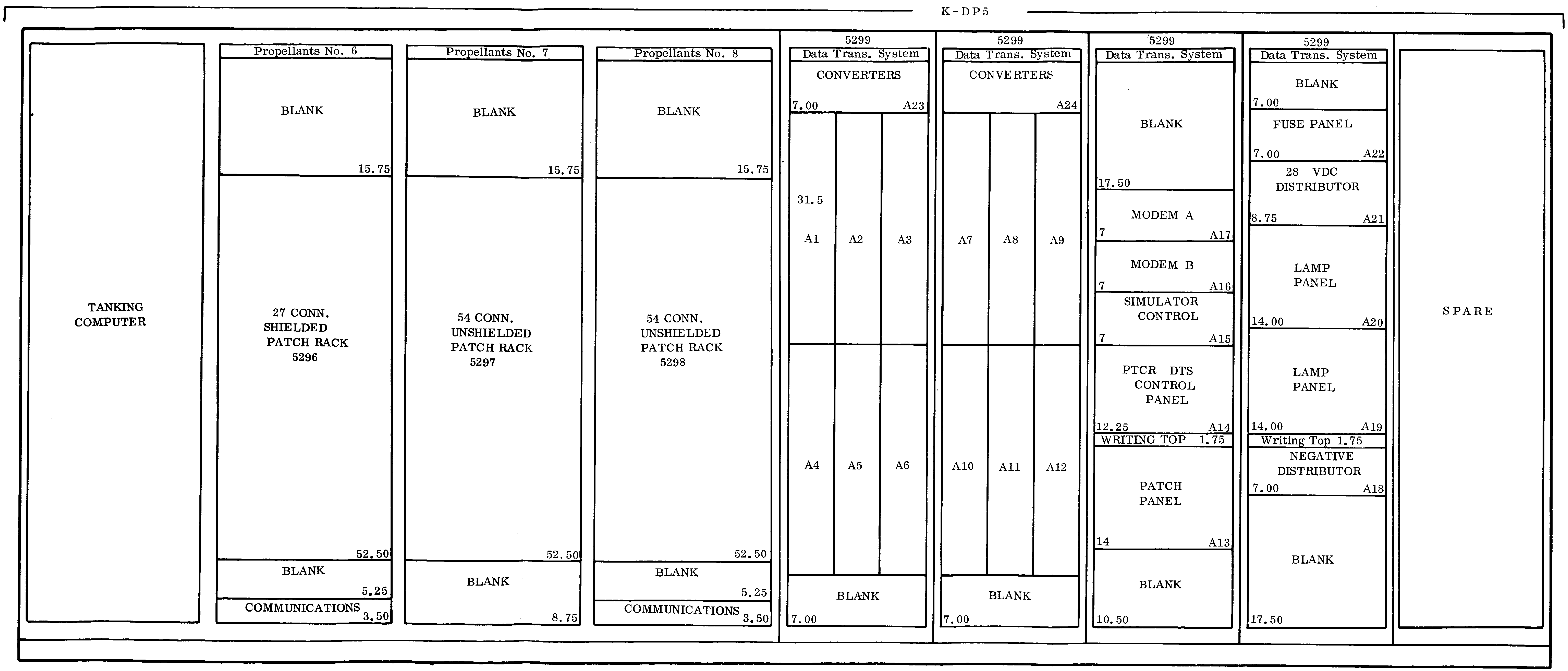


Figure 1-7. Data Transmission System Equipment (Rack Layout)

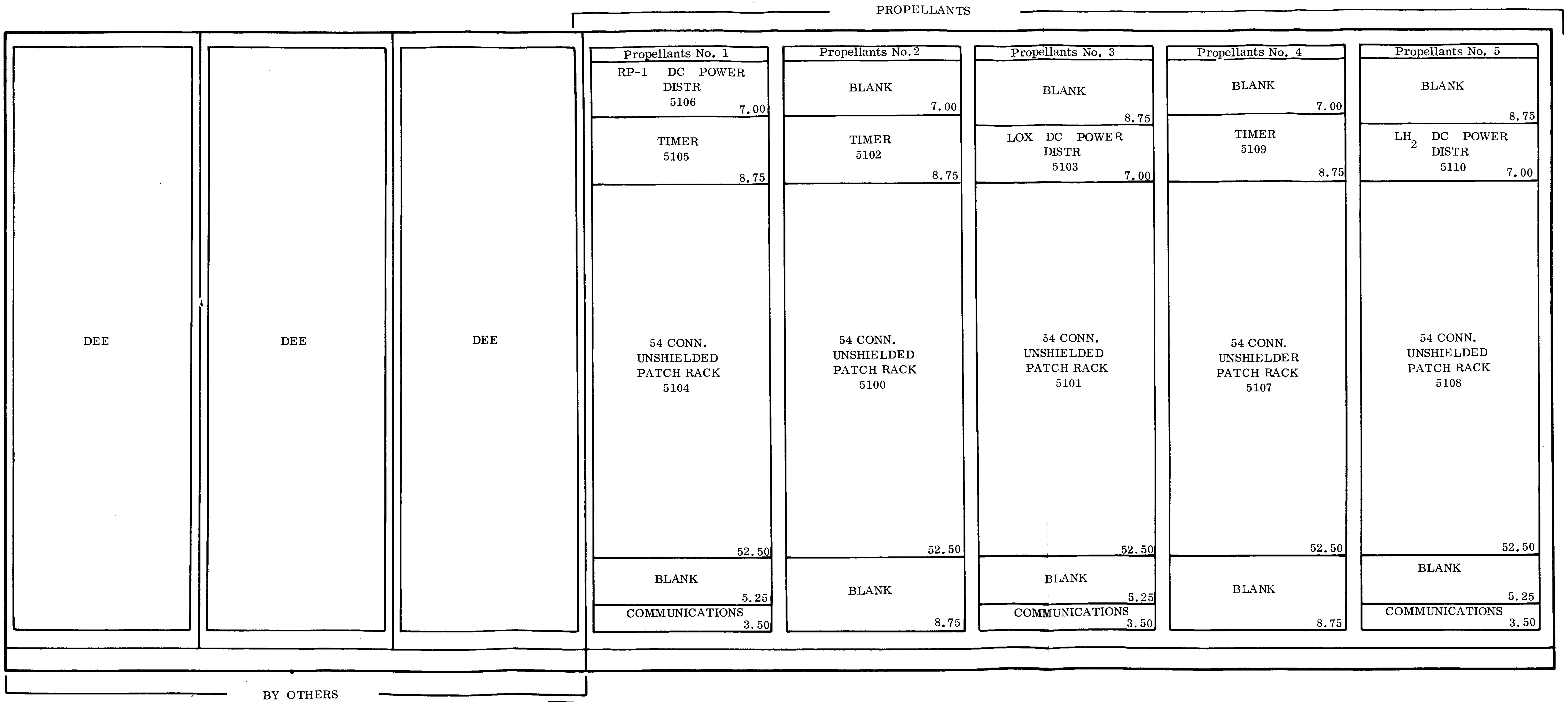


Figure 1-8. Timer Panels, D-C Power Distributors, and Patch Racks (Rack Layout)

1-7. Environmental Control System (ECS) Room. The ECS room contains the chiller units, high temperature fluid reheat tank, medium temperature reheat tank, three (3) water cooled packaged air conditioners, the cooling tower, and all their associated electrical equipment such as pumps, blower, and fan motors, electrical heaters, and electrically operated dampers, diverters and valves.

Approximately 52 A-C electric motors ranging in size from 1 hp to 125-hp, are utilized in the ECS system to drive various pumps, blowers, fans, and compressors.

ECS Electrical Control and Monitor Equipment located in the ECS room is listed in table 1-1.

1-8. HIGH PRESSURE STORAGE BATTERY

High Pressure Storage Batteries are located at each launch pad area and at the VAB. Each battery consists of high pressure storage vessels of 12,000 cu. ft. capacity together with associated pneumatic hardware.

Electrical circuits at the high pressure storage area consist of storage pressure level readouts and readouts of Δ P across the filters to the converter-compressor facility.

1-9. LAUNCH CONTROL CENTER

The LCC contains the electrical equipment listed in table 1-2 for each firing room (equipment functions are described under the pertinent system descriptions covered in other sections of this document).

Located in each firing room in the LCC are ten (10) consoles for the control, test, and monitoring of Launch Equipment Branch LUT Electrical Support Equipment. The face layout and the criteria of the panels are furnished by the Launch Equipment Branch. The design and fabrication is the responsibility of the Astrionics Laboratory, Marshall Space Flight Center. The panels are listed below:

a. Hydraulic charging unit system: LCC summation panel, figure 1-9.

b. Service arms system: S-II Intermediate (typical), summation panel, figure 1-10.

c. Tail service mast system: Tail service mast 3-4, figure 1-11.

Table 1-1. ECS Electrical Control and Monitor Equipment Located in the ECS Room

ECS No. 1 Contains	ECS No. 2 Contains	ECS No. 3 Contains	ECS No. 4 Contains	ECS No. 5 Contains	ECS No. 6 Contains	ECS No. 7 Contains	ECS No. 8 Contains
Negative Bus Distributor	Regulated A-C Power Distributor No. 1	Cooling Tower Controller Converter	Service Module & Spare Controller Recorder	Regulated A-C Power Distributor No. 2	S-IVB Aft & S-II Fwd Controller Recorder	S-II Aft & S-II Aft Electrical Controller Recorder	Thermistor Distributor
ECS D-C Power Distributor	Heat Systems Controller Recorder	Chiller Converter	Service Module Converter	Instrument Unit and Command-LEM Controller Recorder	S-IVB Converter	S-II Aft Electrical Converter	S-I Fwd & S-I Aft Controller Recorder
Meter Panel	H-H Con-verter	Recorder	Spare Converter	Instrument Unit Converter	S-IVB Fwd Converter	S-II Aft Converter	S-I Fwd Converter
Patch Rack	M-H Converter	Cooling Systems Distributor	Compart-ment Distributor No. 5	Command-LEM Converter	Compart-ment Distributor No. 2	Compart-ment Distributor No. 3	S-I Aft Converter
	Heat Systems Distributor			Compart-ment Distributor No. 1			Compart-ment Distributor No. 4

Table 1-2. Launch Control Center Electrical Equipment

ECS & PROPELLANT LOADING PANELS	DTS (10 racks)	PROPELLANTS	INTERFACE ROOM (4 racks)
ECS Control Monitor Panel	Converters	Shielded Patch Rack	320 Ampere Hour Battery
ECS Vehicle Control and Monitor No. 1 Panel	Modems A & B	Two (2) Unshielded Patch Racks	Battery Charger
ECS Vehicle Control and Monitor No. 2 Panel	Simulator Control	Power supplies	Battery Distributor
ECS Vehicle Control and Monitor No. 3 Panel	PTCR DTS Control Panel	D-C Power Distributor	D-C Control Panel
ECS Vehicle Control and Monitor No. 4 Panel	LCC DTS Control Panel	A-C Power Distribution	500 Ampere D-C Static Power Supply
DC Control and Monitor Panel	Fuse Panel	Circuitry Distributor	A-C Power Distributor
Two (2) LH_2 Control PTCS Panels	+28 Volt Distributor	Signal. Distributor	Static Power Supply Distributor
LH_2 Control Panel	Lamp Panels		Main D-C Power Distributor
LH_2 Components Panel	Negative Distributor		Negative Bus Distributor
LH_2 Monitor Panel			Negative Bus
RP-1 Control PTCS Panel			

Table 1-2. Launch Control Center Electrical Equipment (Cont.)

ECS & PROPELLANT LOADING PANELS	DTS (10 racks)	PROPELLANTS	INTERFACE ROOM (4 racks)
RP-1 Control Panel			
RP-1 Components Panel			
Three (3) LOX Control PTCS Panels			
Two (2) LOX Components Panels			
LOX Control Panel			

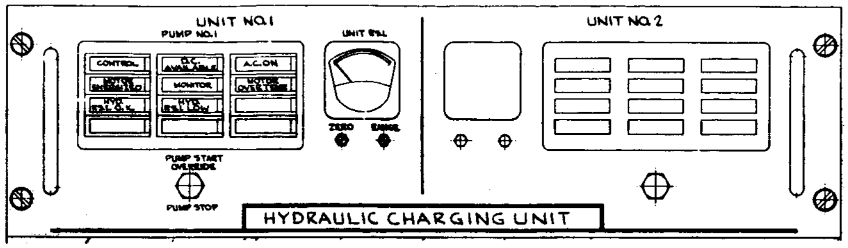


Figure 1-9. Hydraulic Charging Unit System, LCC Summation Panel

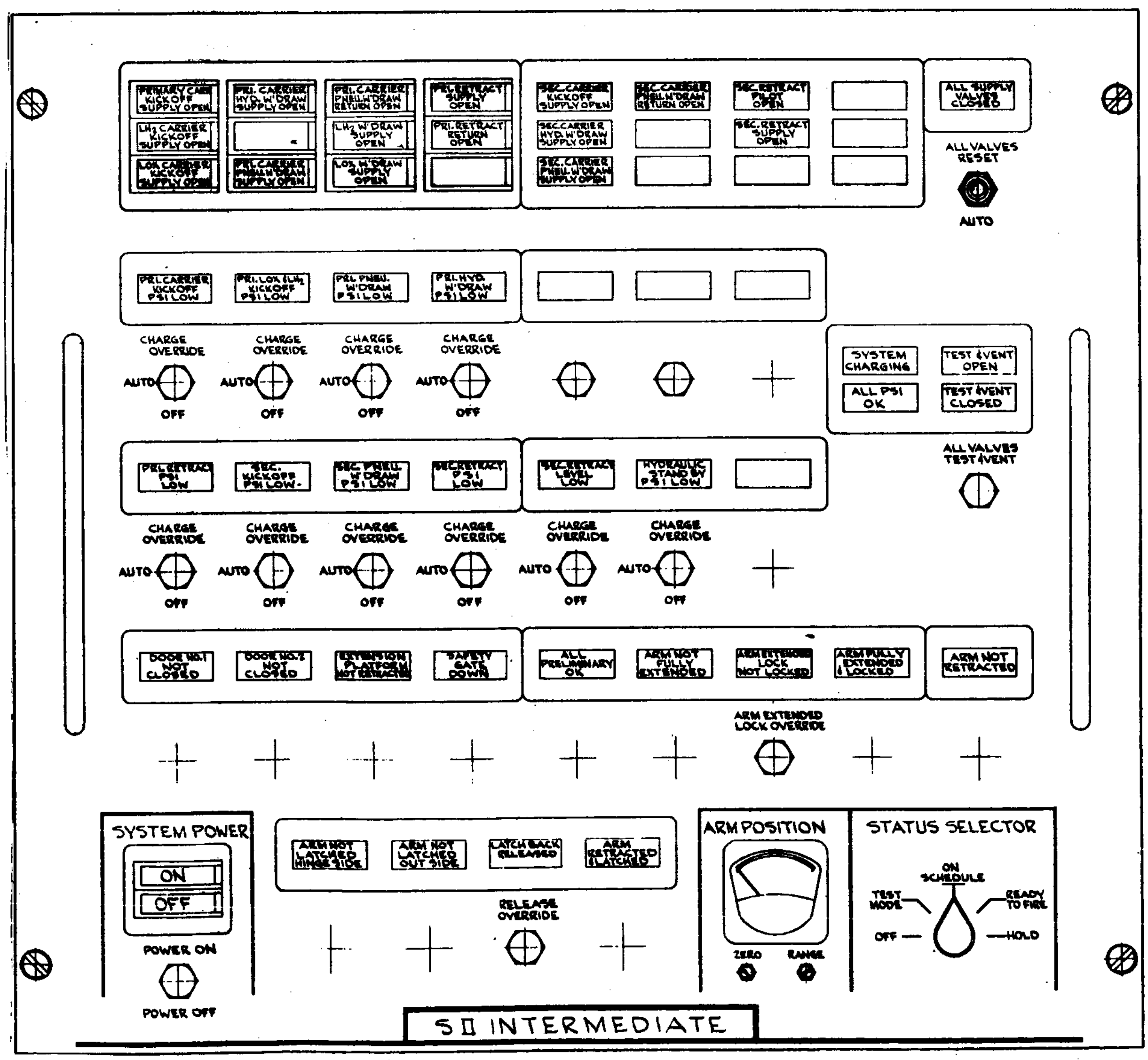


Figure 1-10. Service Arms System, S-II Intermediate (Typical), Summation Panel

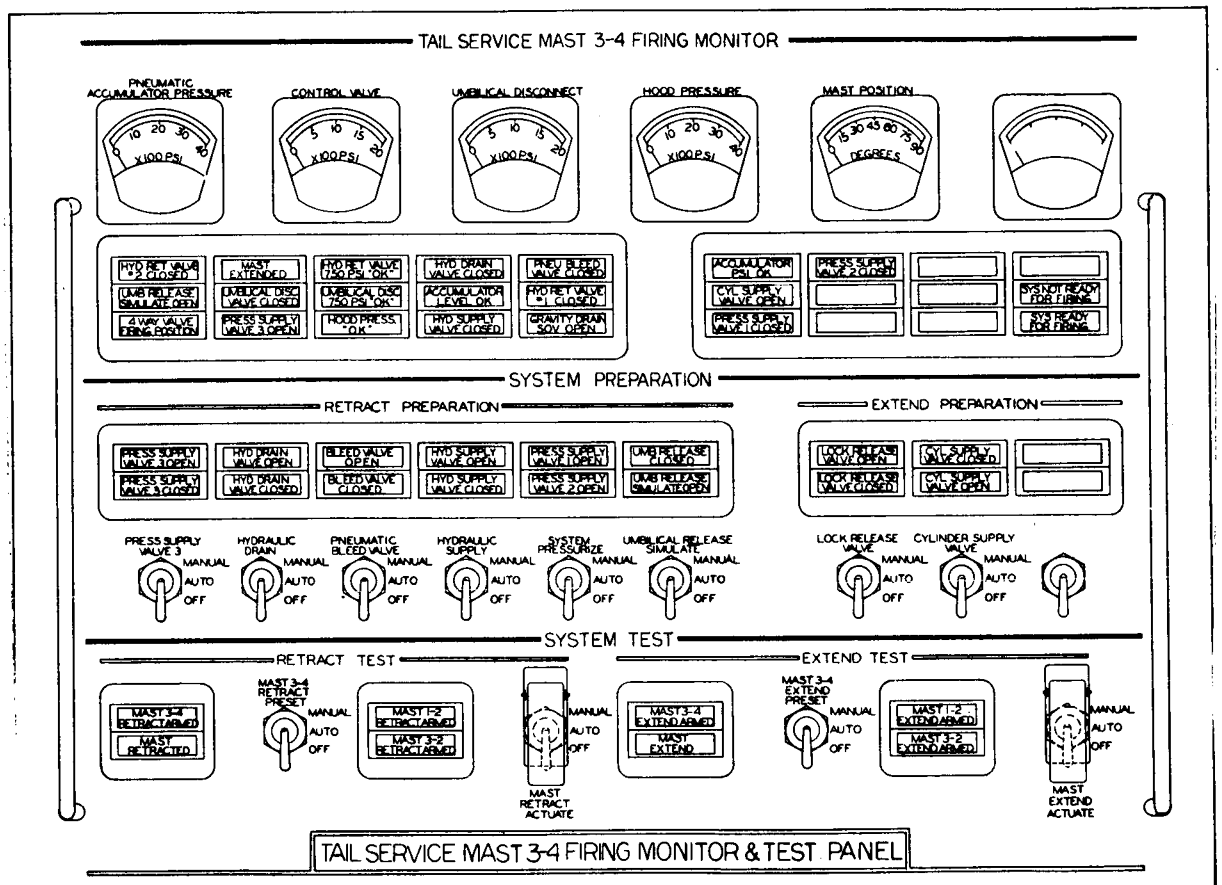


Figure 1-11. Tail Service Mast System

d. Launcher accessories system: Firing accessories system: Firing accessories test panel, figure 1-12.

e. Firing circuits subsystem: Summation panel, figure 1-13.

f. Q-Ball cover removal system: (To be provided)

g. Oxygen monitoring system: (To be provided)

h. 28 volts D-C system: (To be provided)

1-10. VERTICAL ASSEMBLY BUILDING

The VAB contains the following electrical equipment:

a. Storage Battery
Two (2) racks containing the N_2 Gas Analyzer Monitors.

b. VAB Engine Servicing Platform.

The VAB engine servicing platform is used as an accessory of the LUT in the Vertical Assembly Building to service the S-IC engine area, install the engine skirts and change out an inboard or outboard F-1 engine.

1-11. LAUNCHER UMBILICAL TOWER

The LUT contains the Propellants Branch equipment listed below:

a. Propellants Rack No. 1 and 2 containing the following:
1 Negative Bus Distributor
1 LUT D-C Power Distributor
1 14-connector Shielded Patch Rack

b. 2 Tower-Vehicle Simulators

c. LUT Propellant Computer Racks

The Launch Equipment Branch equipment located in the LUT consists of relay racks, power racks, firing batteries, terminal distributors, control distributors power suppliers, ground test sets and various other items.

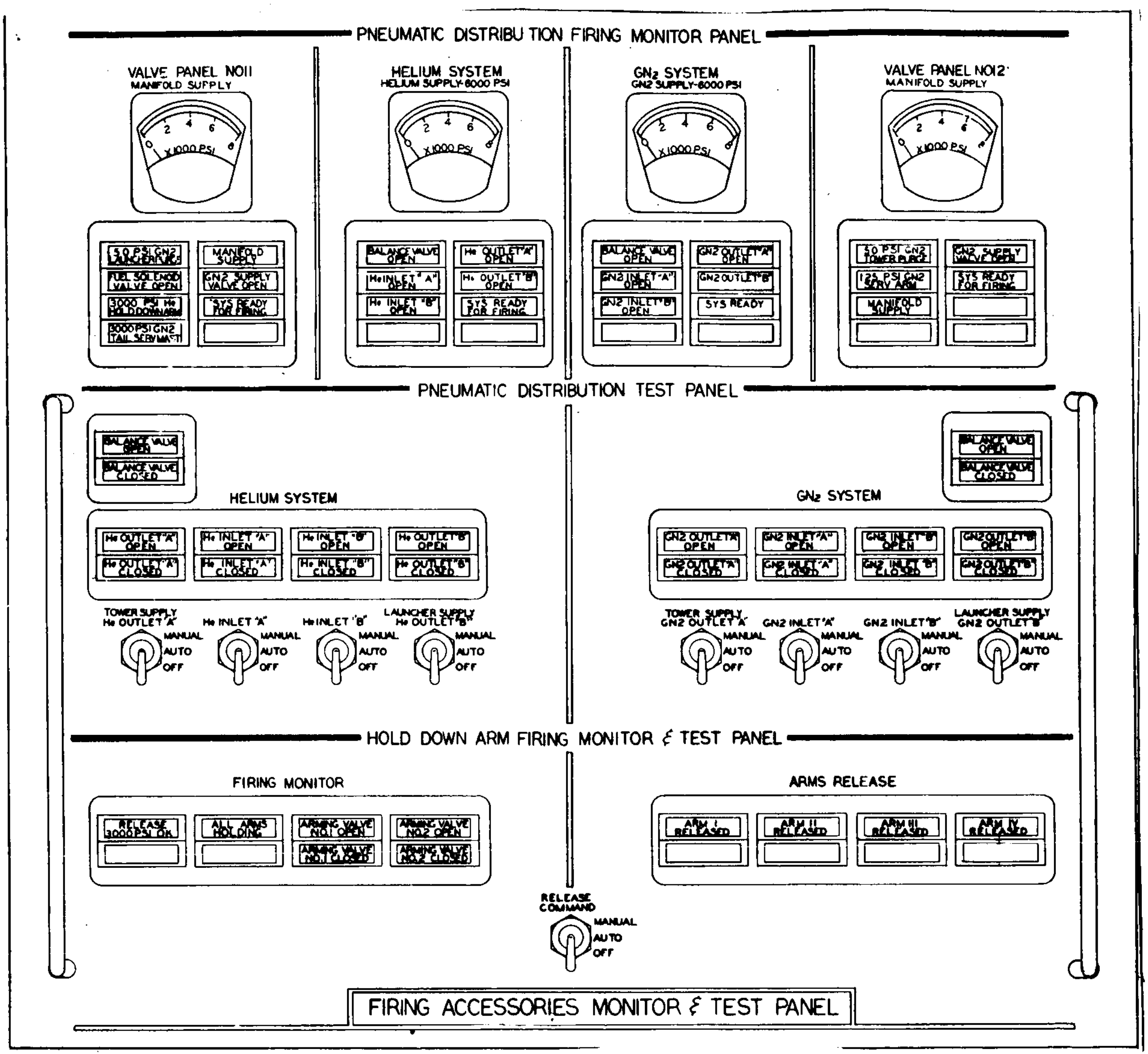


Figure 1-12. Firing Accessories System, Test Panel

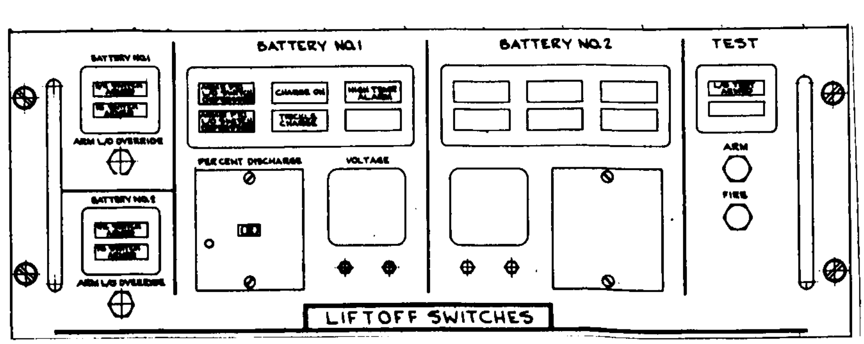


Figure 1-13. Firing Circuits System, Summation Panel

SECTION II
PROPELLANT TANKING SYSTEMS

2-1. LOX TRANSFER ELECTRICAL SYSTEM

The Liquid Oxygen (LOX) System consists of the LOX storage area and the LOX transfer system. Included in the storage area is the Electrical Equipment Building which houses the following Propellants Branch electrical control equipment:

1 Main Control Distributor
1 Instrumentation Distributor
2 Controllers for the 2500-hp Main Transfer Pump Motors
2 Starters for the 2500-hp Main Transfer Pump Motors
2 Controllers for the 200-hp Replenish Pump Motors
2 Starters for the 200-hp Replenish Pump Motors
1 440-volt Power Panel
2 118-vac Regulated Transformer

LOX Storage Area Rack No. 1 containing:
- 1 Converter Panel
- 1 Instrumentation Power Supply Panel
- 1 Replenish Pump Programmer Panel
- 1 Drain Flow Panel

LOX Storage Area Rack No. 2 containing:
- 1 Main Pump Programmer Panel
- 1 Alarm Selector Panel
- 1 Instrumentation Power Supply Panel

LOX Storage Area Rack No. 3 containing:
- 1 Replenish Pump Programmer Panel
- 1 Convertor Panel
- 1 Main Pump Programmer Panel
- 1 Alarm Selector Panel

The LOX system provides liquid oxygen for filling and replenishing the Saturn V vehicle LOX tanks for each stage. The electrical system provides for the operation, control, checkout, and monitoring of the LOX transfer system which is performed remotely from the LCC.

The LOX system employs two main 10,000-gpm centrifugal transfer pumps, one operational and one on standby, each powered by a 2,500-hp, fan cooled 1,800-rpm, 4,160-vac, 3-phase, induction motor. Two (2) replenish pumps are utilized, one operational and one on standby, each powered by a 200-hp, 4,160-vac, fan cooled, 3-phase, induction motor. The main pump is used during the fast fill operation of the S-II and S-IC stages. The replenishing pump fast fills the S-IVB stage and provides for topping and maintaining oxidizer levels in the tanks. The replenish valves are controlled by the propellant tanking computer system (PTCS).

Located within each firing room of the LCC are six (6) panels: Three (3) LOX Control PTCS Panels, two (2) LOX components panels, and one (1) LOX Control Panel. The control panel controls power, fill commands, drain commands, and the mode of operation as illustrated in figure 2-1. The components panels control and monitor various functions in the S-IC, and S-IVB stages, the storage area, and the LUT. The PTCS panels control and monitor the LOX replenishing operations.

Conditions monitored and controlled in the vehicle's three stages by the K-DP LOX System ESE are vent valve positions, fill and drain valve positions, over pressure indications, and overfill indications. Conditions monitored and controlled in the storage area are storage tank level, storage tank pressure, tank vent valve positions, replenish by-pass valve positions, main fill precool valve positions, main fill line vent and drain valve, main fill line drain valve, replenish line vent valve, replenish line drain valve, pump suction valves, and replenish pump chill-down valves. Conditions monitored and controlled in the LUT are the umbilical line drain valve positions, umbilical vent shut-off; S-IVB main fill, slow fill and replenish valves; S-II main fill, main fill shut-off, slow fill, replenish and replenish shut-off valves; S-IC main fill, slow fill, replenish, main fill shut-off, replenish shut-off, replenish shut-off, emergency fill and drain, emergency fill and drain vent.

Control is provided for the LOX system in the LCC control panel for automatic loading, simulate, and manual arming. The simulate command executes automatic sequencing of the entire LOX tanking operation without actual transfer of the LOX or operation of the transfer pumps. The LOX is cut off manually at the storage tank when the system is operated in the "simulate" mode. The Manual Arming Command energizes a series of toggle switches on the components panels, the operation of which permit any of the following actions:

a. Individual operation of any components in the system.

b. Operation of a series of components to execute any sequence in the LOX tanking cycle.

c. Capability of performing the entire LOX transfer operation manually.

d. Manual operation of selected components or series of components at any chosen point while in the automatic mode.

The panel face layouts of the components panels are given in figures 2-2 and 2-3. The LOX loading in the automatic mode is controlled by relay logic located in the PTCR.

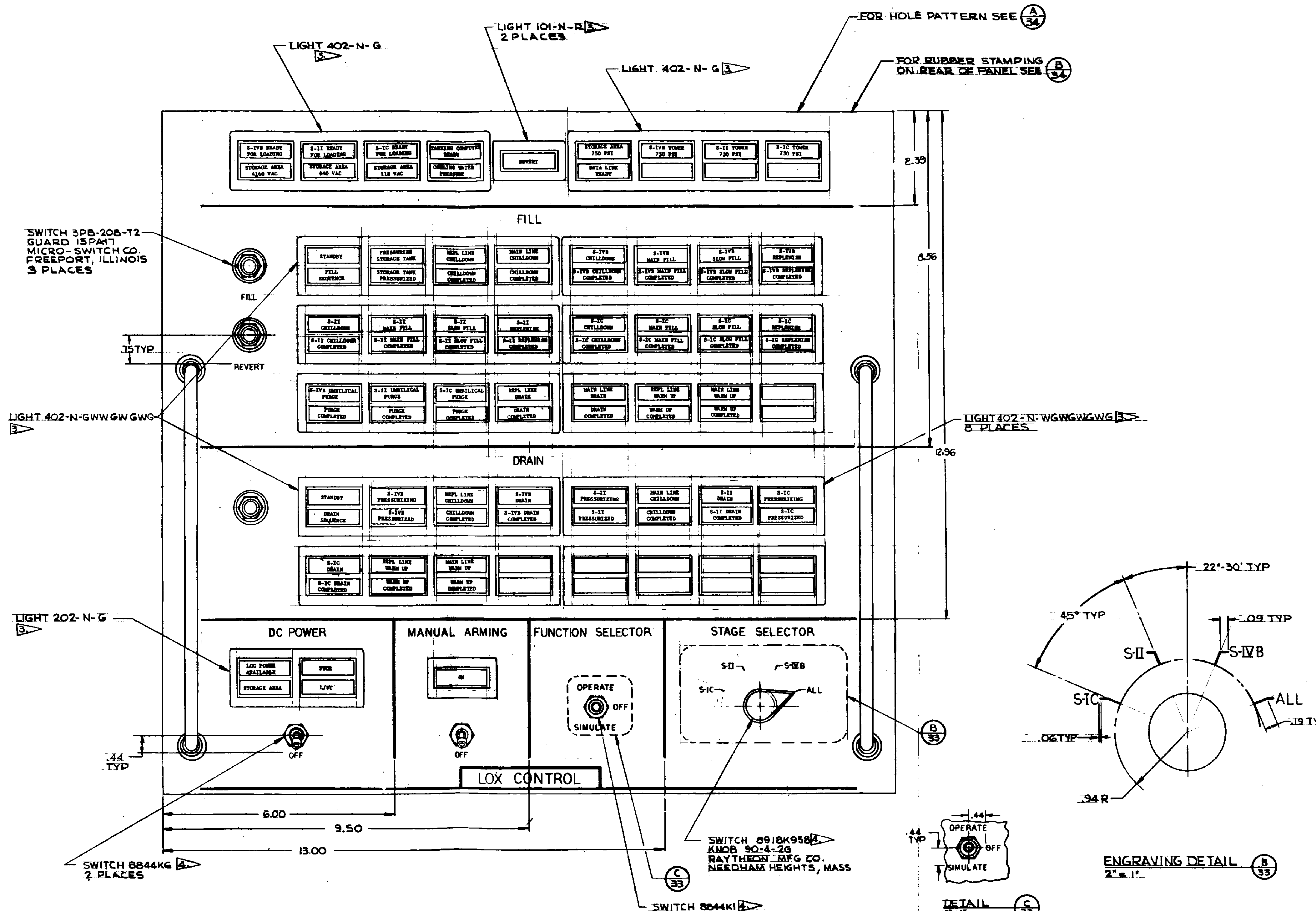


Figure 2-1. LOX Control Panels

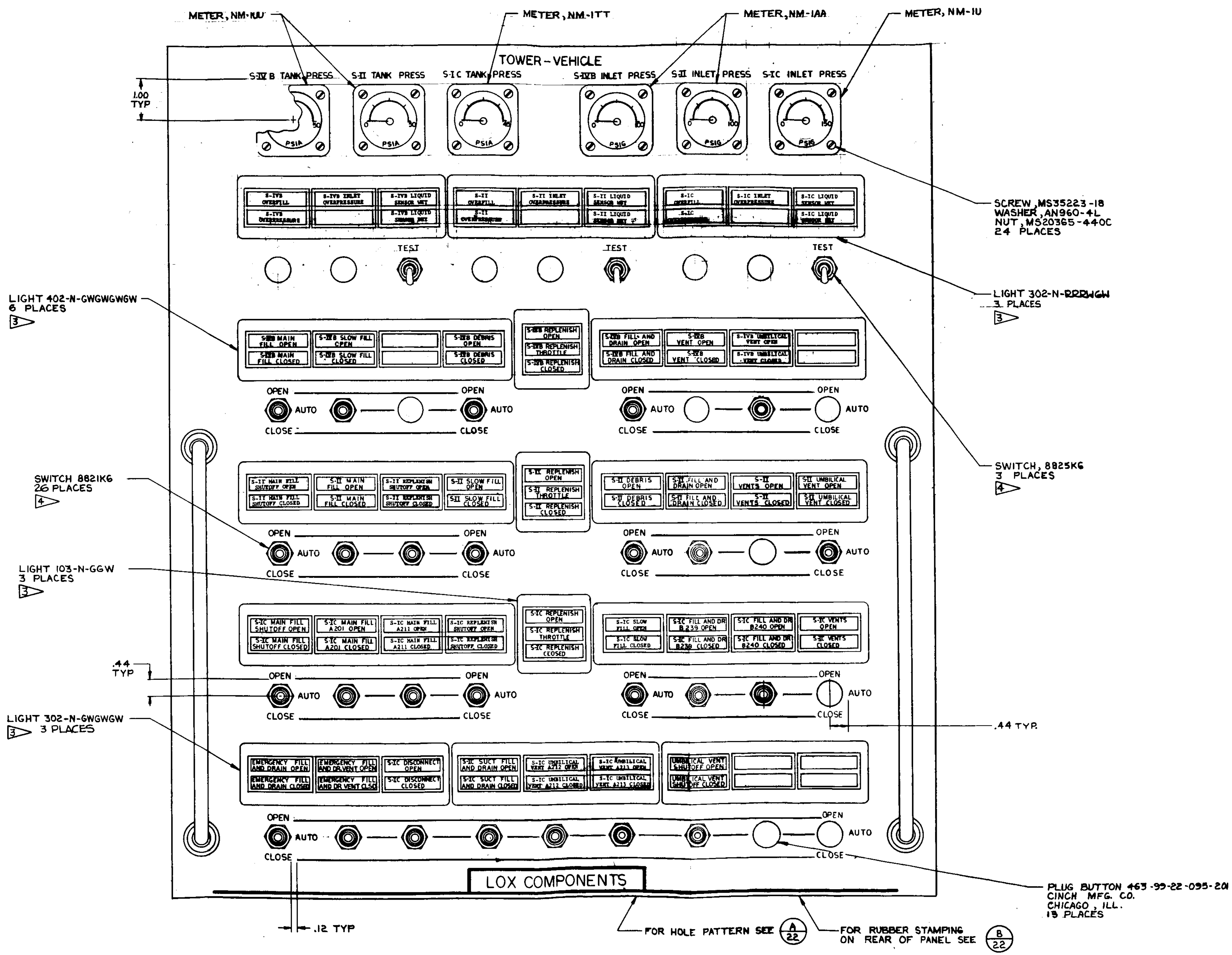


Figure 2-2. LOX Components Panel Face Layout

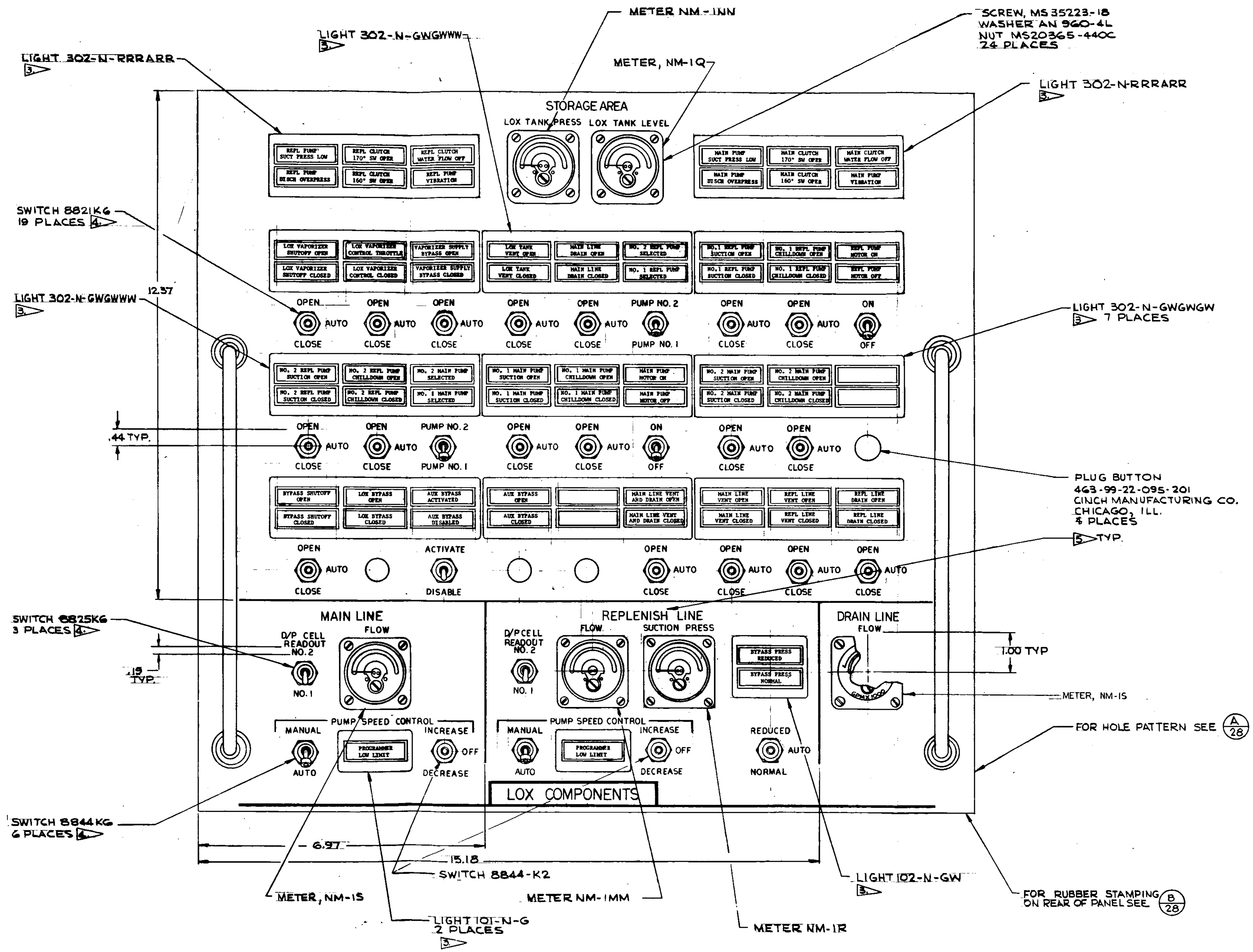


Figure 2-3. LOX Components Panel Face Layout

Control commands from the LCC and status information exchange between the LCC and the PTCR are transmitted via the Data Transmission System (DTS) which has two identical units, one located in the LCC and the other in the PTCR. Redundant hardwire circuits are utilized for certain critical safing function. Hardwires are also used to interconnect the PTCR with the LUT and LOX storage area. A description of the DTS is given in a subsequent section of this document.

Direct Current power for the LOX systems is supplied by a power distributor situated in propellants racks Nos. 2 and 3, located in the PTCR. Also contained herein are a timer panel and three (3) patch racks. This equipment rack contains the timers and relay logic necessary to operate the LOX system.

Located in the LUT are propellants racks 1 and 2, which contain the negative bus distributor, D-C power distributor and a patch rack which also contains a portion of the LOX relay logic circuitry.

The Propellant Tanking Computer System (PTCS) provides signals to the LOX system which are utilized during the automatic sequence for controlling and maintaining the vehicle oxidizer tanks liquid levels at the required mission level. The mission level is maintained by the LOX system through the replenish valves which are modulated by the PTCS.

When the LUT is not at the launch pad, simulators which electrically simulate the LUT equipment are used to checkout and verify the LOX system. The simulators and checkout equipment utilized in the LOX system checkout are:

a. Storage Facility Simulator
b. LUT Simulator
c. Facility Checkout Box
d. PTCR Simulator
e. Tower-Vehicle Simulator (used on the LUT)

NOTE

The loading procedure for the LOX and LH_2 propellants for Saturn V has notbeen defined at this date, neither has the requirement for leak checks prior to the LOX and LH_2 main fill loading. Therefore, the loading sequence descriptions herein contained do not cover the loading order of the cryogenic propellants and the leak check operation in the loading sequency is omitted.

The LOX loading sequence procedure is as follows: When prerequisite conditions are met throughout the LOX system, the LOX storage tank is pressurized to 10 psig, and the precool initial sequence is executed on the 6" vacuum jacketed line which is the main fill line for the S-IVB stage and the replenishing line for the entire vehicle.

After an interval of time, the 1,000-gpm pump is started at reduced flow rate by use of the speed controller and precool is continued to the S-IVB.

When precool is complete as indicated by a 5% liquid level on the S-IVB, fast fill is initiated by increasing the pump flow to 1,000-gpm. The S-IVB is filled to 93% and replenishing is initiated.

Precooling of the 14" main fill line using tank pressure begins when the S-IVB is 40% full with precool gases being vented through the S-II and S-IC. When the S-IVB reaches 93% full, precooling of the 14" line continues with reduced flow from the 10,000-gpm pumps by using the speed controller. At this time the S-IC fill valves are closed.

When the 14" line precool is complete as indicated by S-II LOX depletion probes the flow is increased to 5,000-gpm. The S-II is filled to 93% capacity. Replenishing of S-II is initiated and slow fill of S-IVB to 100% is begun.

Reduced flow to the S-IC follows completion of S-II 93% filling. This is done to insure precool of the main fill line to the S-IC and in the event that there has been a delay between S-II and S-IC fill.

Precool advances into fast fill upon indication of 5% liquid level on the S-IC. Fast fill is initiated and at 10% full, slow fill to S-II is begun. S-II is filled to 100%. S-IC fast fill proceeds at 10,000-gpm until the S-IC is filled to 93% at which time the main fill system is shut down and slow fill is used to bring the S-IC to 100%. Replenish, which started simultaneously with slow fill, continues.

Replenishing of all stages is taking place at this time and continues through pressurization. The slow fill capability is employed any time the level in a stage drops below 98%.

During the countdown operations, the LOX level is maintained at mission requirements through the LOX replenish system controlled by the PTCS.

Figure 2-4 is the LOX system schematic and interconnect diagram showing the LOX system equipment and locations, and cable interconnects.

2-2. RP-1 TANKING ELECTRICAL SYSTEM

The RP-1 electrical systems includes equipment in the RP-1 storage area, the RP-1 equipment house, and RP-1 pad area in addition to the equipment located in the LCC, PTCR, and the LUT. Propellants Branch electrical equipment located in the LH_2 RP-1 equipment house includes the following:

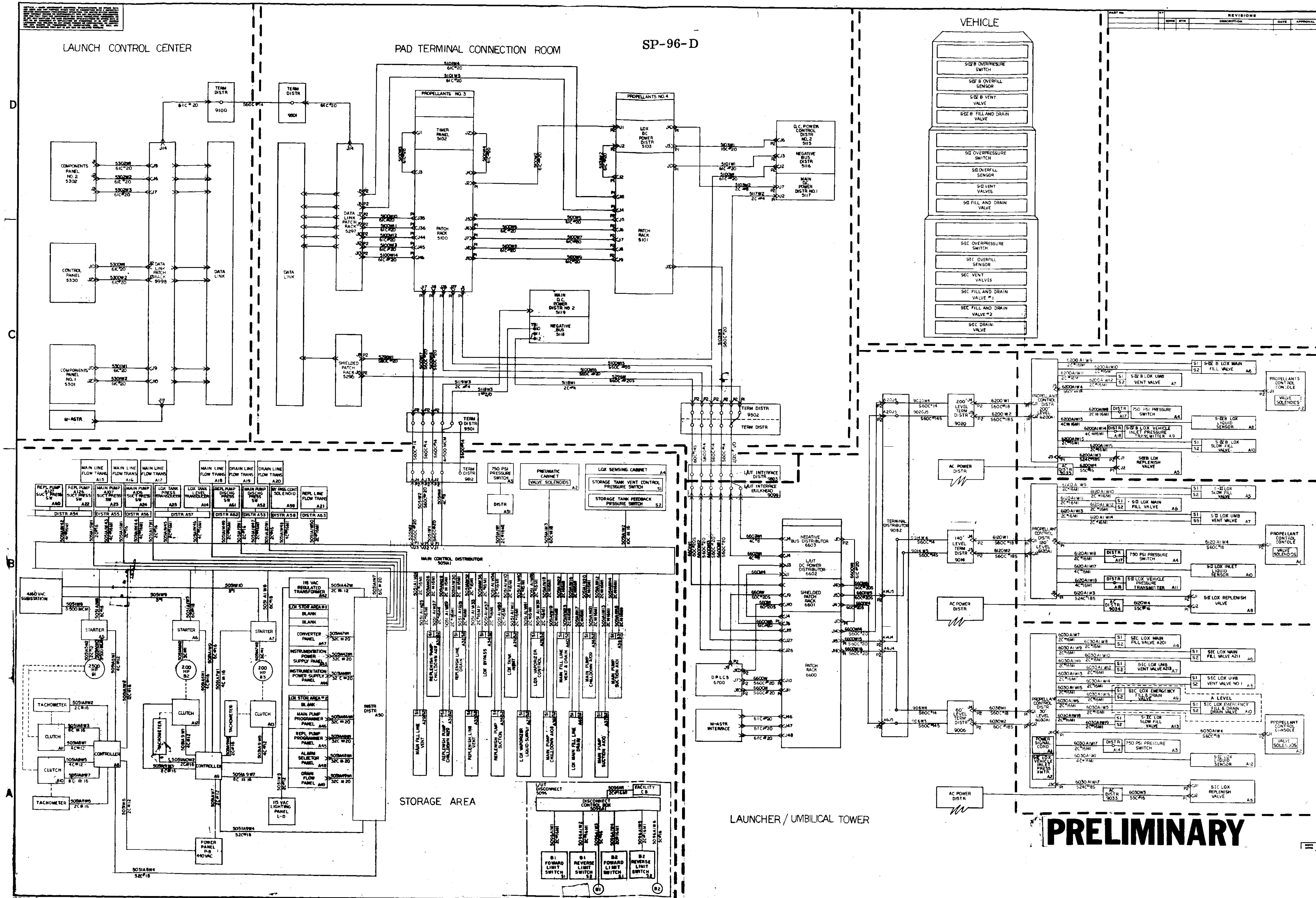


Figure 2-4. LOX System Equipment Locations and Cable Interconnects

1 Main Control Distributor
1 Starter for 300-hp Transfer Pump Motor
1 Starter for 150-hp Circulating Pump Motor
1 Starter for 2-hp Scavenging Pump

The RP-1 system is a remotely controlled system for transferring RP-1 from the fuel storage area into the fuel tank of the Saturn V vehicle S-IC stage.

The RP-1 system employs one 2,000-gpm centrifugal pump powered by a 300-hp, 3,600-rpm, 440-vac, 3 phase, induction motor for fuel transfer. The fuel transfer pump, the fuel circulating pump powered by a 50-hp, A-C motor and the scavenging pump powered by a 2-hp, A-C motor are all located at the storage area.

Each firing room in the LCC contains three (3) racks containing five (5) panels each:

1 RP-1 Temperature Readout Panel
1 RP-1 Control PTCS Panel
1 RP-1 Control Panel
1 RP-1 Components Panel
1 Auxiliary Components Panel

The Control Panel controls the power fill command, drain command, level adjust command, and the mode of operation ("operate, simulate, and manual") for the RP-1 system. The panel face layout is given in figure 2-5. The components Panel monitors and controls various functions on the S-IC stage, launch area and storage area. The components panel face layout is given in figure 2-6. Conditions monitored on the S-IC stage are vent valve positions, fill and drain valve positions, and overfill indications. Monitored in the storage area are fast fill valve positions, slow fill positions, pump motor conditions, liquid sensor indications, gravity drain valve positions, power drain valve positions, and RP-1 temperature at transfer pump and filters.

The RP-1 system is provided with both automatic and manual control.

Control commands from the LCC and status information exchange between the LCC and the LUT are transmitted via the Data Transmission System (DTS). Redundant hardwire circuits are utilized for certain critical safing functions. Hardwires are also utilized to interconnect the PTCR to the LUT and the RP-1 storage area.

The sequence of operation for RP-1 loading is as follows: provided that the RP-1 system is in standby condition, the S-IC stage fill sequence is initiated. RP-1 flows from the storage area to the base of the launcher at a rate of 2,000-gpm. At this point, the flow rate is decreased to 200 gpm while RP-1 flows through the transfer

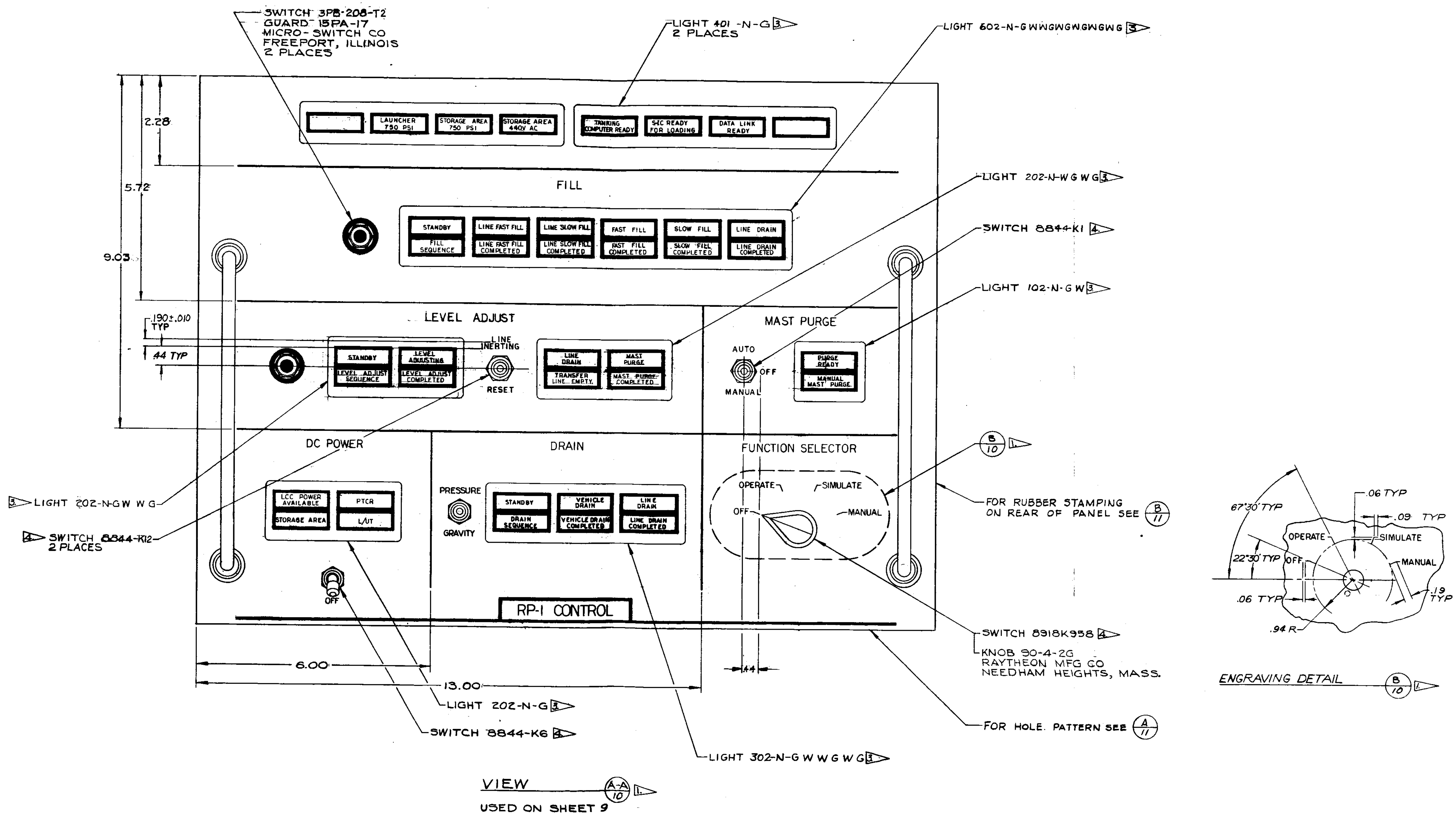


Figure 2-5. RP-1 Control Panel Face Layout

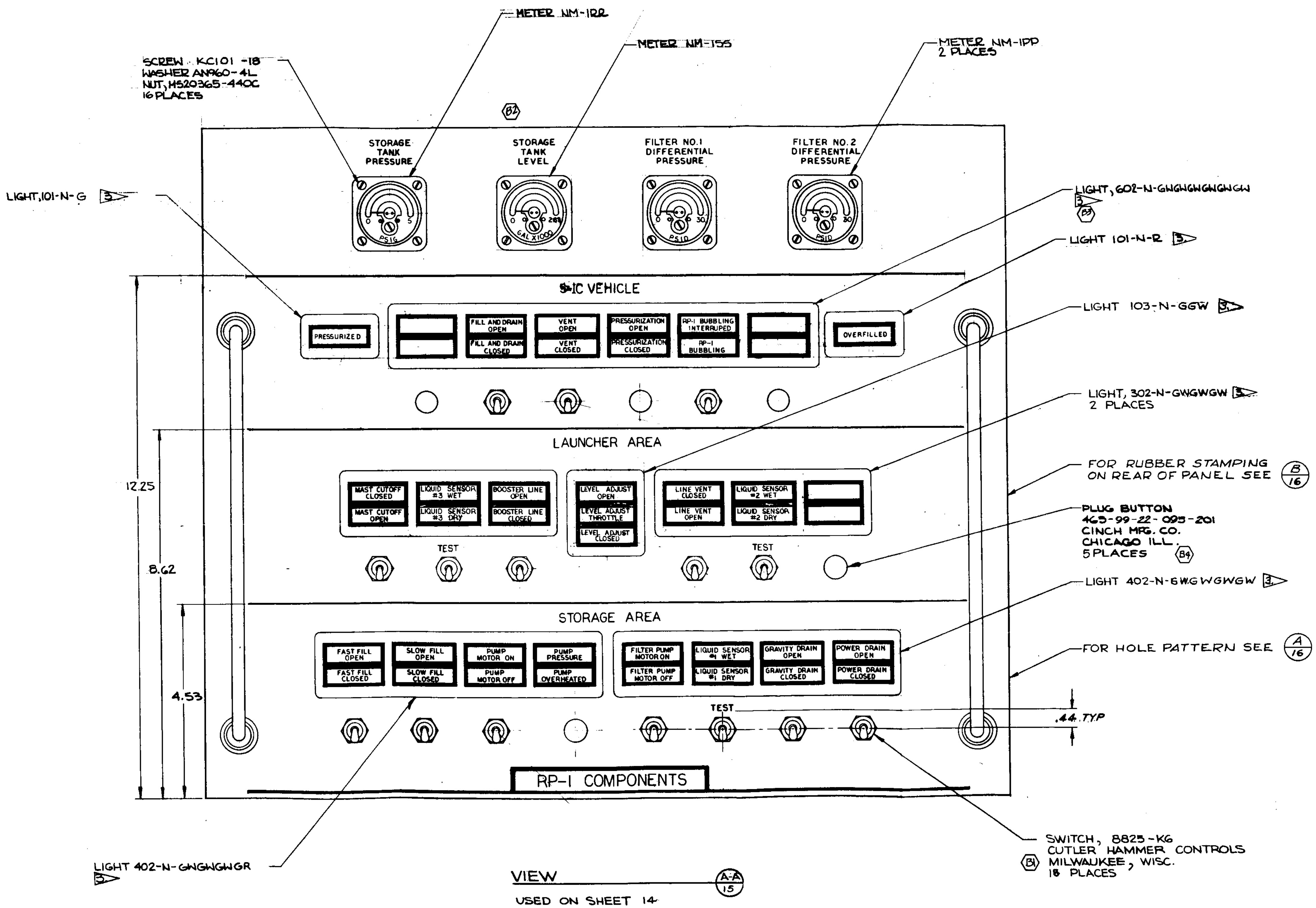


Figure 2-6. RP-1 Components Panel Face Layout

lines in the LUT, allowing the line filters to fill up. The flow rate is then increased to 2,000 gpm until the 98% fill level in the S-IC fuel tank is reached.

At the 99% level in the loading sequence, the fuel flow is decreased to 200 gpm by means of the vehicle slow fill operation and RP-1 flow continues to the 102% level in the S-IC fuel tank. At this time, the fuel in the transfer line is drained back to the storage tank through the jet eductor.

At the appropriate time in the countdown, the level adjust command is executed and the S-IC fuel tank is drained through the level adjust valve to the 100% mission level. The level adjust valve is a throttling valve controlled by the PTCS. Just prior to engine ignition, the line inerting sequence is executed which completes the fuel loading sequence.

In the event of an aborted launch, the S-IC stage fuel tank is drained by initiating the drain command. The fuel tank is gravity drained until it is empty, following which a power drain operation is utilized to complete the draining of the transfer line.

The RP-1 schematic showing the electrical system interconnects and the electrical equipment locations is given in figure 2-7.

2-3. LIQUID HYDROGEN TRANSFER/ELECTRICAL CONTROL SYSTEM

The liquid hydrogen (LH_2) system consists of the storage facility, the transfer system, and the venting system.

Propellants Branch electrical equipment for the LH_2 system located in the RP-1/LH_2 equipment house is as follows:

1 Main Control Distributor
1 GN_2 Distributor

DP electrical equipment at the storage area is listed below:

1 LH_2 Pad Distributor
1 Burn Pond Cabinet

The LH_2 propellant loading system is a remotely controlled system utilizing to purge all LH_2 transfer lines and the S-II and S-IVB LH_2 tanks, and to transfer LH_2 propellant from the storage facility into the S-II and the S-IVB stages of the Saturn V.

The LH_2 propellant transfer is effected by pressurization of the storage dewar. This is accomplished by means of a vaporizer-heat exchanger system which provides an internal operating pressure of 75 psig. The LH_2 is thereby

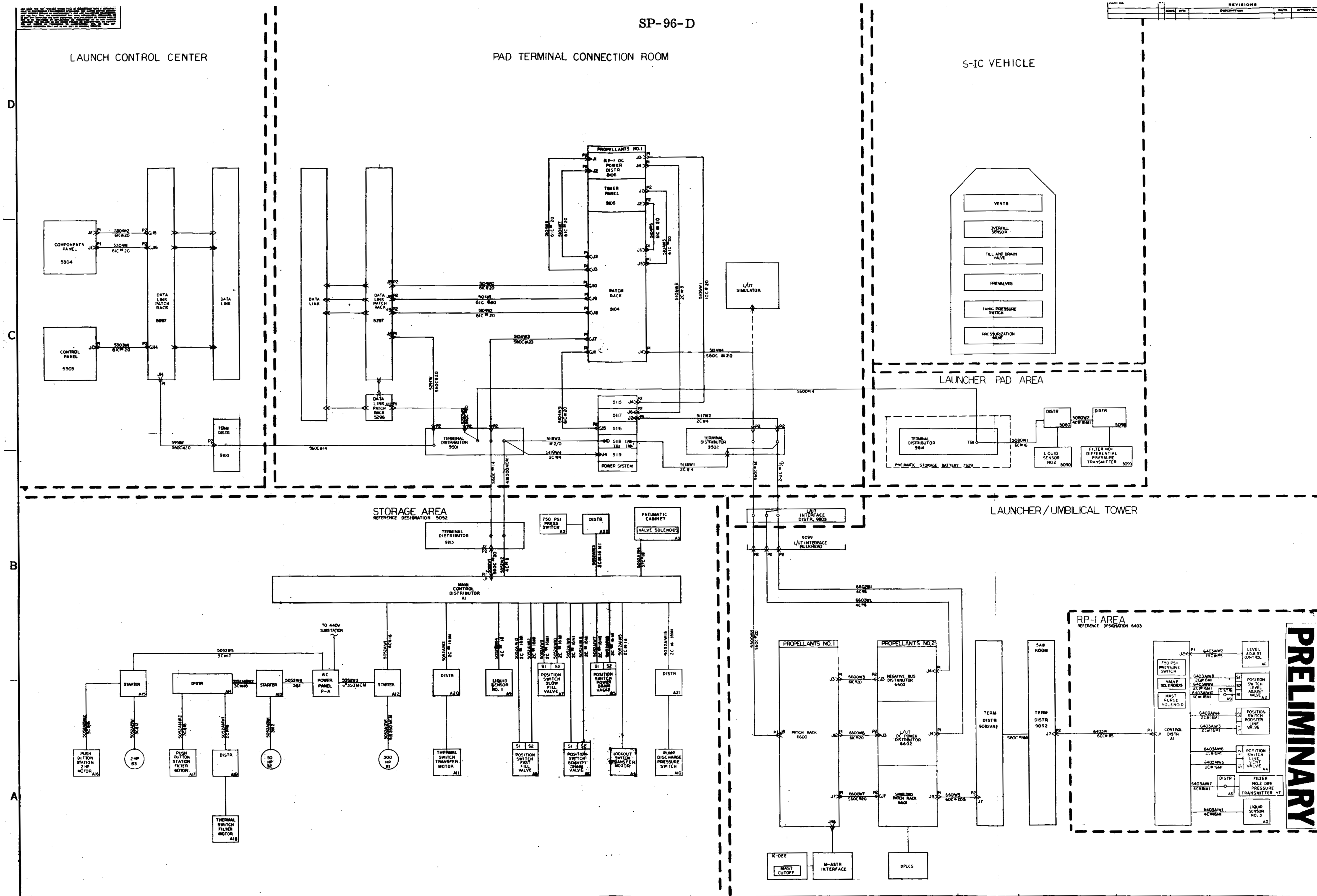


Figure 2-7. RP-1 System Equipment Locations and Cable Interconnects

forced through the valving network and into the LH_2 tanks of the S-II and S-IVB stages.

Located in the Launch Control Center are six (6) panels:

1 LH_2 Control Panel
2 LH_2 Components Panels
2 LH_2 PTCR Panels
1 Auxiliary Components Panel

The control panel controls power, vehicle purge commands, fill and drain commands, and the mode of operation. The face layout of the control panel is given in figure 2-8. The components panel monitors and controls various functions in the S-II and S-IVB stages, the LUT, and the storage area. The LH_2 monitor panel monitors status information at the storage area and at the LUT. Conditions monitored and controlled by the components panel for the S-II and S-IVB stages are vent valve positions, fill and drain valve positions, vehicle tank overpressures, overfill and level indications; monitored and controlled from the LUT are fill line vent valve positions, umbilical vent purge valve positions, transfer line valve positions, and debris valve positions; monitored and controlled from the storage area are standby vent valve positions, transfer line vent valve positions, vehicle purge valve positions, vaporizer by-pass valve control positions, chill-down valve positions, and storage tank vent valve positions. The monitor panel monitors various functions in the LUT, vehicle and storage area. Monitored from the LUT are filter differential pressures, transfer line pressure, and vent pressures; monitored in the vehicle are LH_2 tank pressures; monitored from the storage area are tank liquid levels and pressures. The face layout for the LH_2 components panel and the LH_2 monitor panel is given in figures 2-9 and 2-10.

Control is provided for the LH_2 system in the LCC control panel for automatic loading, simulate, and manual arming. The simulate command executes automatic sequencing of the entire LH_2 tanking operation without actual transfer of LH_2. The simulate mode is executed with the LH_2 shutoff manually at the storage dewar. The manual arming command energizes a series of toggle switches in the components panel which permits any of the following actions:

a. Individual operation of any component in the LH_2 system.
b. Operation of a series of components to execute any chosen sequence in the LH_2 tanking cycle.
c. Capability of performing the entire LH_2 transfer operation manually.
d. Manual operation of any component or sequence of components at any chosen point while in the automatic mode.

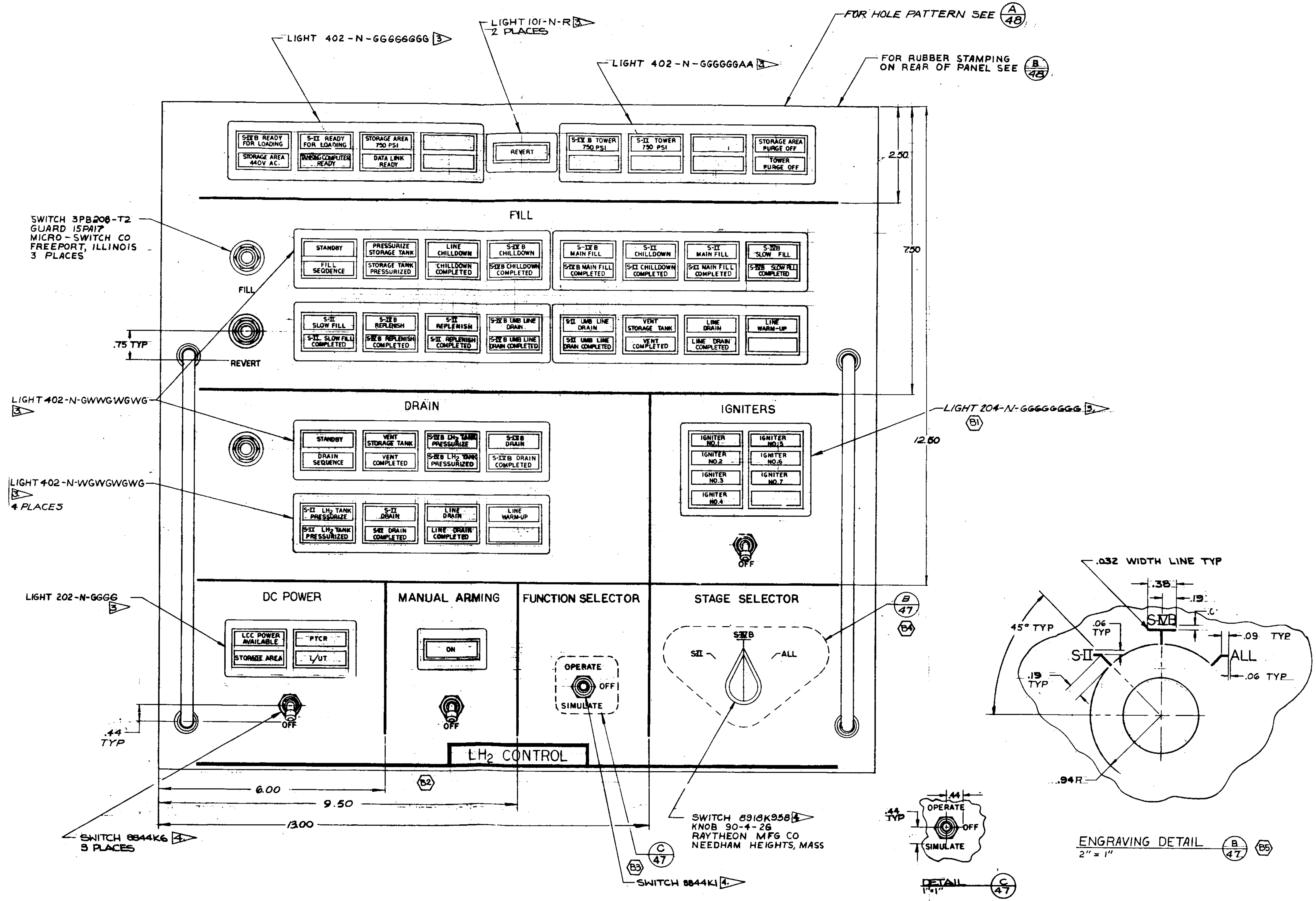


Figure 2-8. LH_2 Control Panel Face Layout

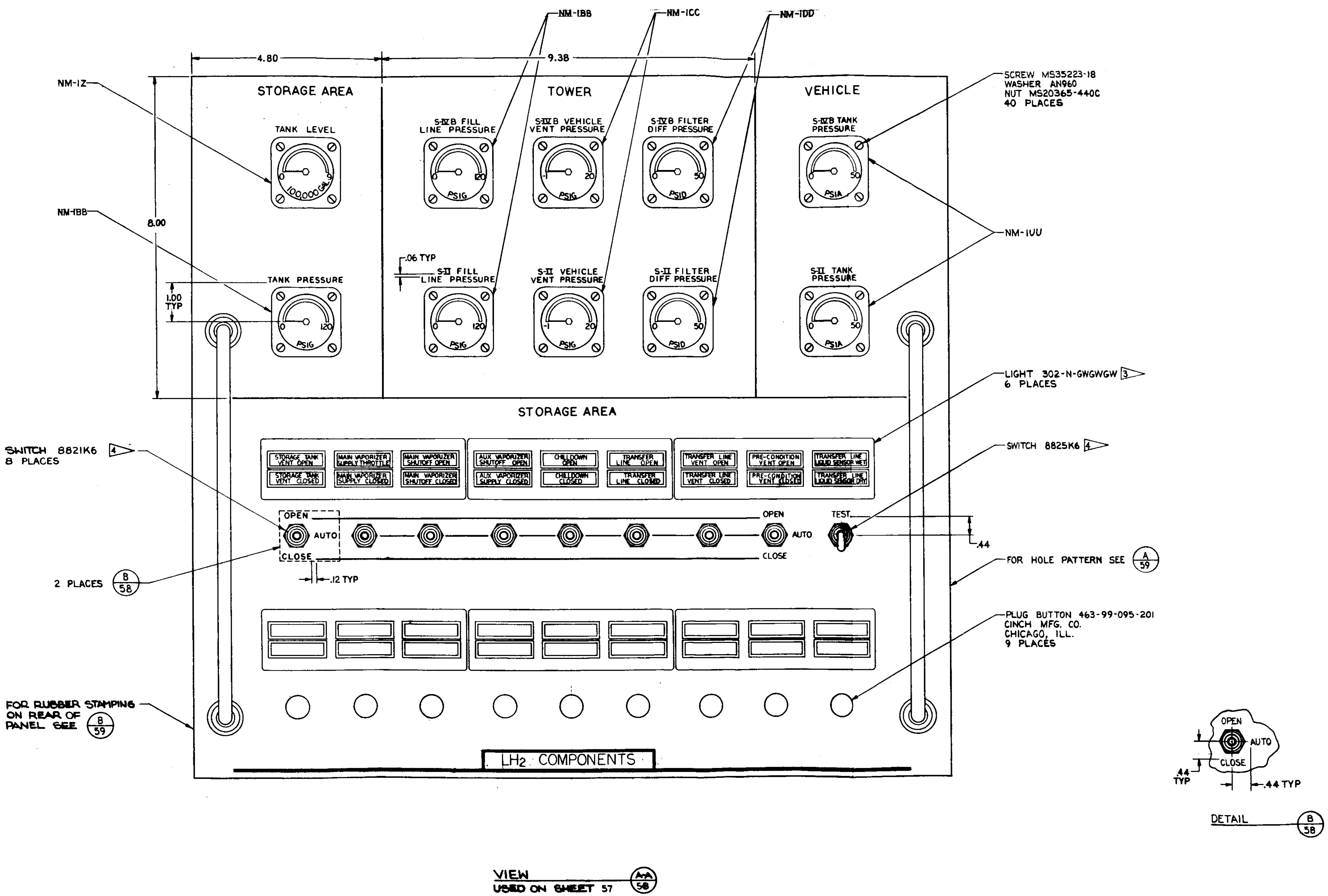


Figure 2-9. LH_2 Component Panel Face Layout

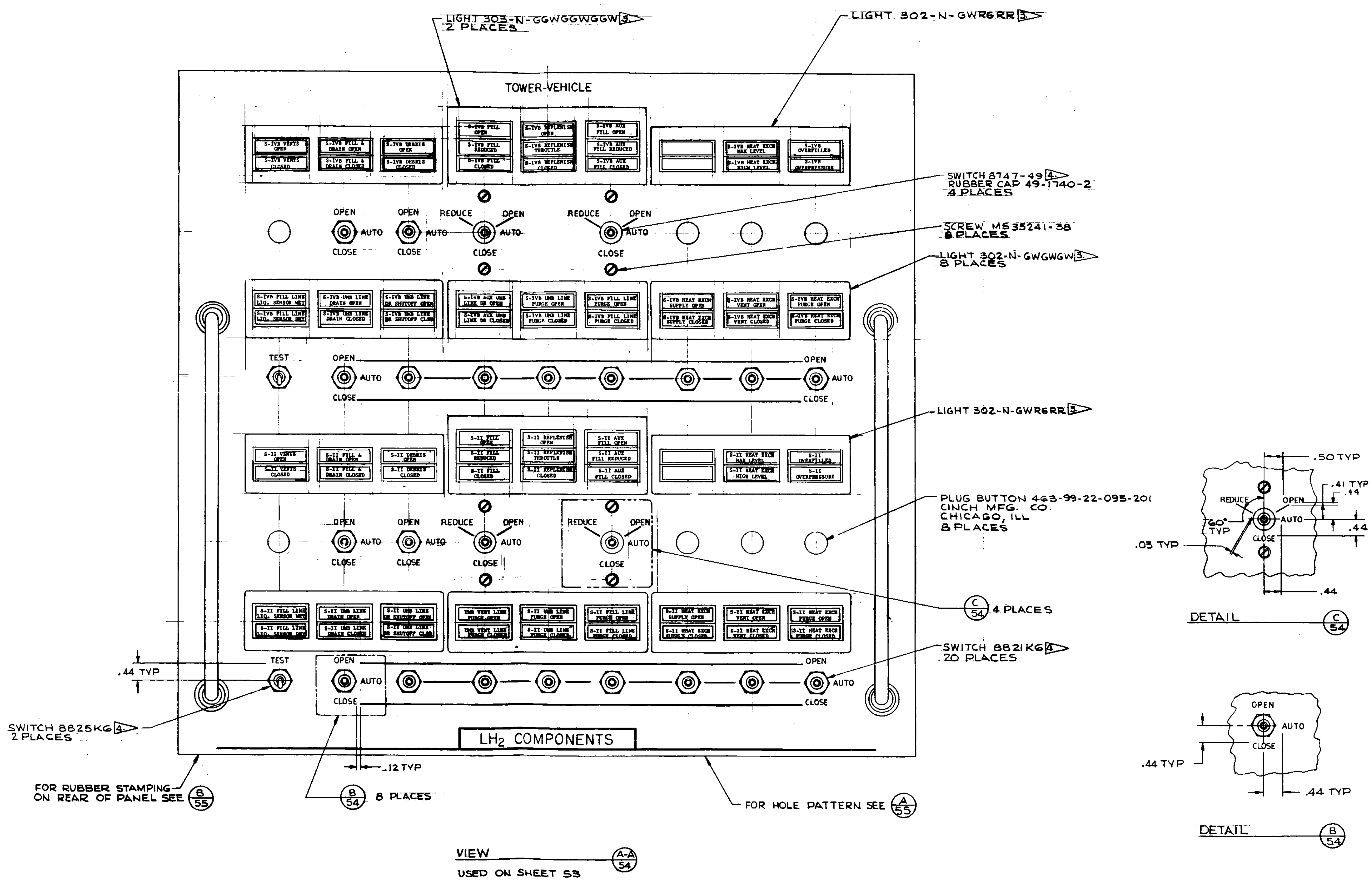


Figure 2-10. LH_2 Monitor Panel Face Layout

Control commands from the LCC and status information exchange between the LUT and the LCC are transmitted via the Data Transmission System (DTS) which has two identical units, one located in the LCC and the other in the PTCR. Redundant hardwire circuits are utilized for certain critical safing functions. Hardwire are also used to interconnect the PTCR with the LUT and the LH_2 storage area. A description of the DTS is given in a subsequent section of this document.

Direct current power is supplied for the LH_2 system from propellants rack No. 5 which holds the LH_2 power distributor and a patch rack. Propellant rack No. 4 holds the timer panel and patch rack which contain the timers and relay logic circuitry required to operate the LH_2 system.

Propellant rack No. 1 is located in the LUT and contains the negative bus distributor, the LUT D-C power distributor and a 27-connector patch rack. Propellants rack No. 2 holds a patch rack which also contains part of the LH_2 relay logic circuitry.

The Propellant Tanking Computer System (PTCS) provides the signals during the automatic loading sequence which control and maintain the LH_2 level in the S-II and S-IVB propellant tanks at the 100% full or mission level.

Simulators are used to electrically replace the LUT when it is not positioned at the launch pad. The simulators required to check out the LH_2 system and verify its operation are the ground equipment test simulator, the LUT simulator, the facility checkout box and the PTCR simulator. The cable interconnect diagram for the simulators is given in figure 2-11.

Provided that the LH_2 system is in an inerted standby condition, the LH_2 loading sequence is as follows: Fill Command is executed, the Storage tank is pressurized and transfer line chilldown begins. When the transfer line chilldown is completed the S-IVB chilldown is begun. The transfer line valve is opened and S-IVB fill begins at approximately 500-gpm. When the S-IVB tank reaches 5% full, fast fill of the S-IVB is initiated at approximately 3,000-gpm. Fast fill is terminated at 93% full and chilldown of the S-II fuel tank is initiated. Fast fill of the S-II begins when the liquid level reaches 5% and terminates when the LH_2 level reaches 93%. Slow fill of the S-IVB then is executed at approximately 500 gpm to the 100% level at which point replenishment is continued and slow fill of the S-II at 1,000 gpm is begun. When the S-II reaches 100% full, slow fill is stopped and LH_2 level is maintained by the PTCS at mission level. When vehicle tank pressurization command is executed the PTCS transmits a 100% full signal that closes the vehicle fill and drain valve and sets up the umbilical tower valves for purging.

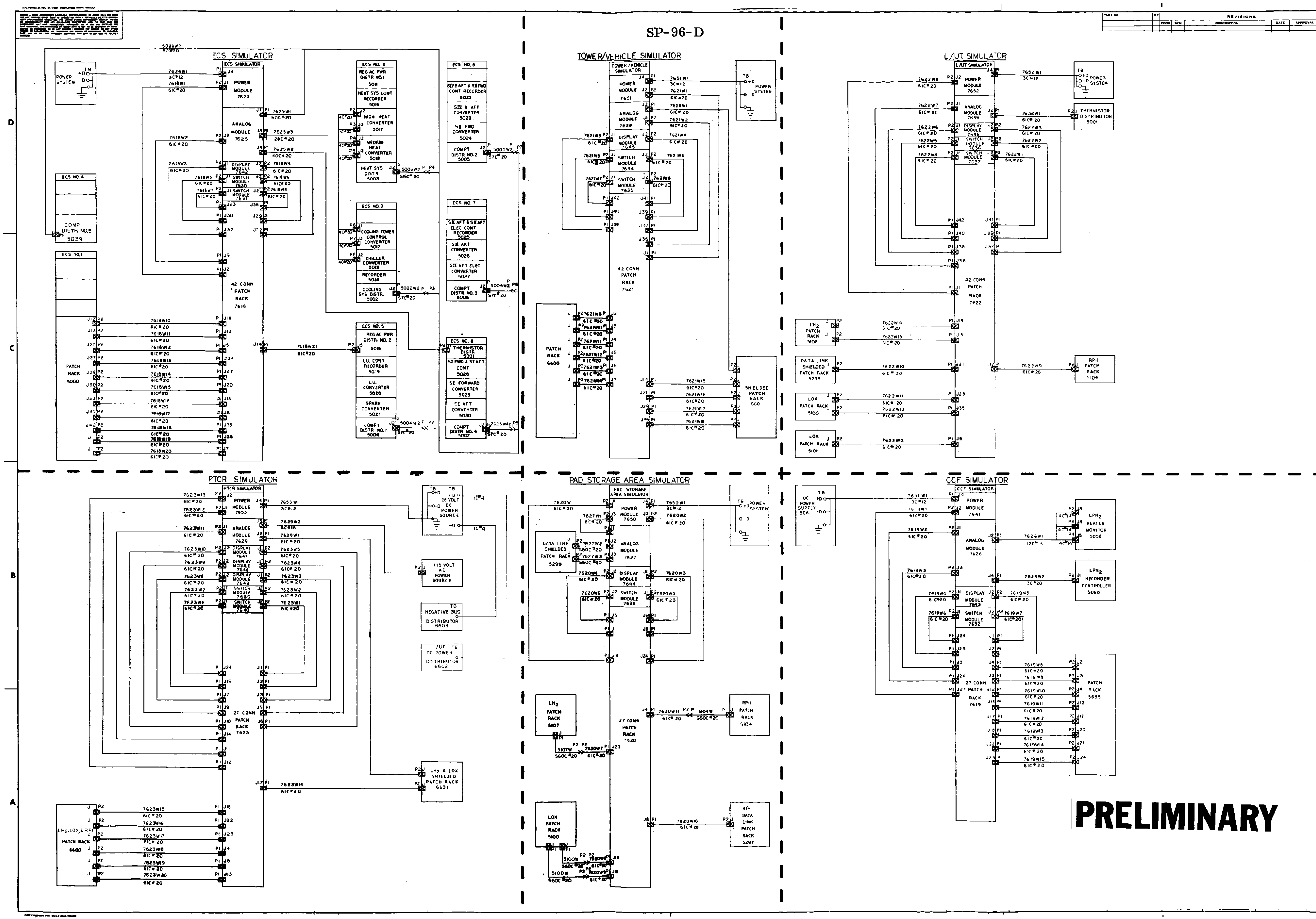


Figure 2-11. Simulators Cable Interconnect Diagrams

2-4. DATA TRANSMISSION SYSTEM

The Data Transmission System (DTS) is an ancillary part of the propellant loading facilities. The DTS receives, multiplexes, and transmits control signals and status information between the Launch Control Center and the propellant loading systems at the launch pad. It is capable of processing and transmitting 968 discrete (0 or 28-vdc) signals and 104 analog (0-5-v) signals per second from the launch pad to the LCC, and 968 discrete (0 or 28-vdc) signals from the LCC to the launch pad.

The DTS consists of two identical units, one located at each launch pad in the Pad Terminal Connection Room (PTCR) and one located in each firing room in the Launch Control Center (LCC). Each unit contains five (5) functional blocks, a modem (modulator-demodulator), timing, processing logic, plus input and output provisions. A block diagram of the DTS is given in figure 2-12.

2-5. MODEM

Two identical modems are situated at each end of the transmission path. A single set at each terminal performs the functions at any one time. An automatic changeover to the other set occurs in the event of a transmission error detection. The transmitter portion of the modem accepts a serial pulse-train from the processing logic and re-formats this data for optimum transmission. This new bit series is used to modulate, through phase reversal, a 2160-cps carrier and this modulated signal is transmitted over the signal lines. The receiver portion demodulates this signal, reconstructs the data train to the original format, and sends it on to the processing logic.

2-6. Timing. Basic system timing is derived from 2400 and 4800-cps modem clock pulses. A set of four (4) staggered timing pulses, each at 104-microsecond duration with 312-microsecond rest, are constructed from these two signals. System set, reset, store, count, and shift are accomplished by these four timing pulses.

2-7. Processing Logic. The transmitter processing logic senses discrete signals, digitizes analog signals, and multiplexes all this information into a time-shared data sequence. The receiver logic de-multiplexes the data train, processes the discrete data for monitor or command drive, and converts the digitized analog signals back to analog form. Also included in this section are provisions for generation and detection of frame and work sync, plus generation and detection of check-bit information for detection of transmission error.

2-8. Inputs. Input data (monitor signals at the pad and command signals at the control center) are routed through external patch racks to the DTS logic

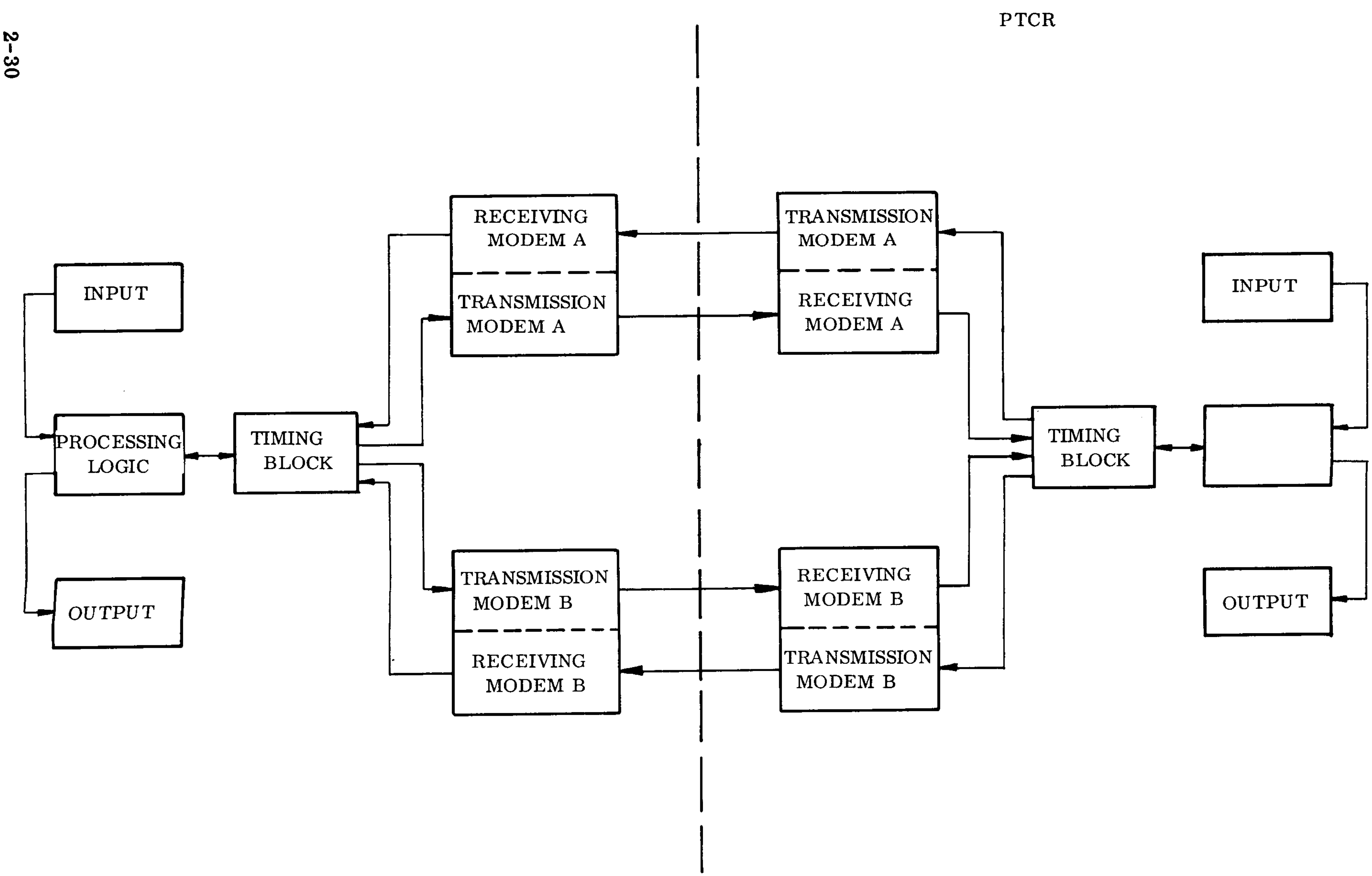


Figure 2-12. DTS Block Diagram

section. Discrete signals are detected by sense amplifiers and then temporarily stored in proper time sequence in the system format shift register. This data is then shifted into the output data train. Analog signals are fed to a switch matrix which selects, again in proper time sequence, one signal at a time for conversion to an eight bit digital word. This word is then processed through the shift register into the data train.

2-9. Outputs. Output data is routed to external systems through patch racks from the DTS logic section. Discrete signals are conditioned by relay drivers to handle external loads. Analog signals, having been converted back to 0-5-v levels, are sent from an output matrix to external systems.

2-10. PROPELLANT TANKING COMPUTER SYSTEM

The Propellant Tanking Computer System (PTCS) for Launch Complex 39 controls the loading and replenishing of LOX, LH_2, and RP-1 aboard each Saturn V vehicle. The PTCS for an individual propellant tank compares propellant level indication inputs from a level sensing system aboard the vehicle with a reference standard, and adjusts the flow or propellant to meet predetermined vehicle requirements. A step-by-step explanation of PTCS operation is detailed below, keyed specifically to S-IVB LOX tank loading. It is also applicable to the S-IVB LH_2 tank PTCS and to the systems employed for the S-II stage. The PTCS designed for the S-IC stages, through largely similar, contain differences which are described in subsequent paragraphs.

2-11. PTCS OPERATION

2-12. Automatic Operation. The PTCS function begins with the energizing of a servo-driven potentiometer. This device, which is mounted on the vehicle, is part of the propellant utilization system for the S-IVB LOX tank. The resultant output signal from the potentiometer varies with the propellant level. This signal and a reference signal are fed to the PTCS, where they are inserted into the automatic computer (figure 2-13).

In the automatic computer, the signals are filtered to minimize noise, and introduced to a summing network. There the level signal is compared with the reference signal, whose value is equivalent to a "100% Flight Mass" indication. The error, or difference between the two signals is then channelled through an amplifier and into the automatic Valve Control Assembly where the electrical signal from the computer is converted into a modulated pneumatic pressure which in turn controls the setting of the Replenish Valve. A ramp generator and standardization circuit in the computer can be switched into the signal circuit to simulate the vehicle signals, or to calibrate the readouts on

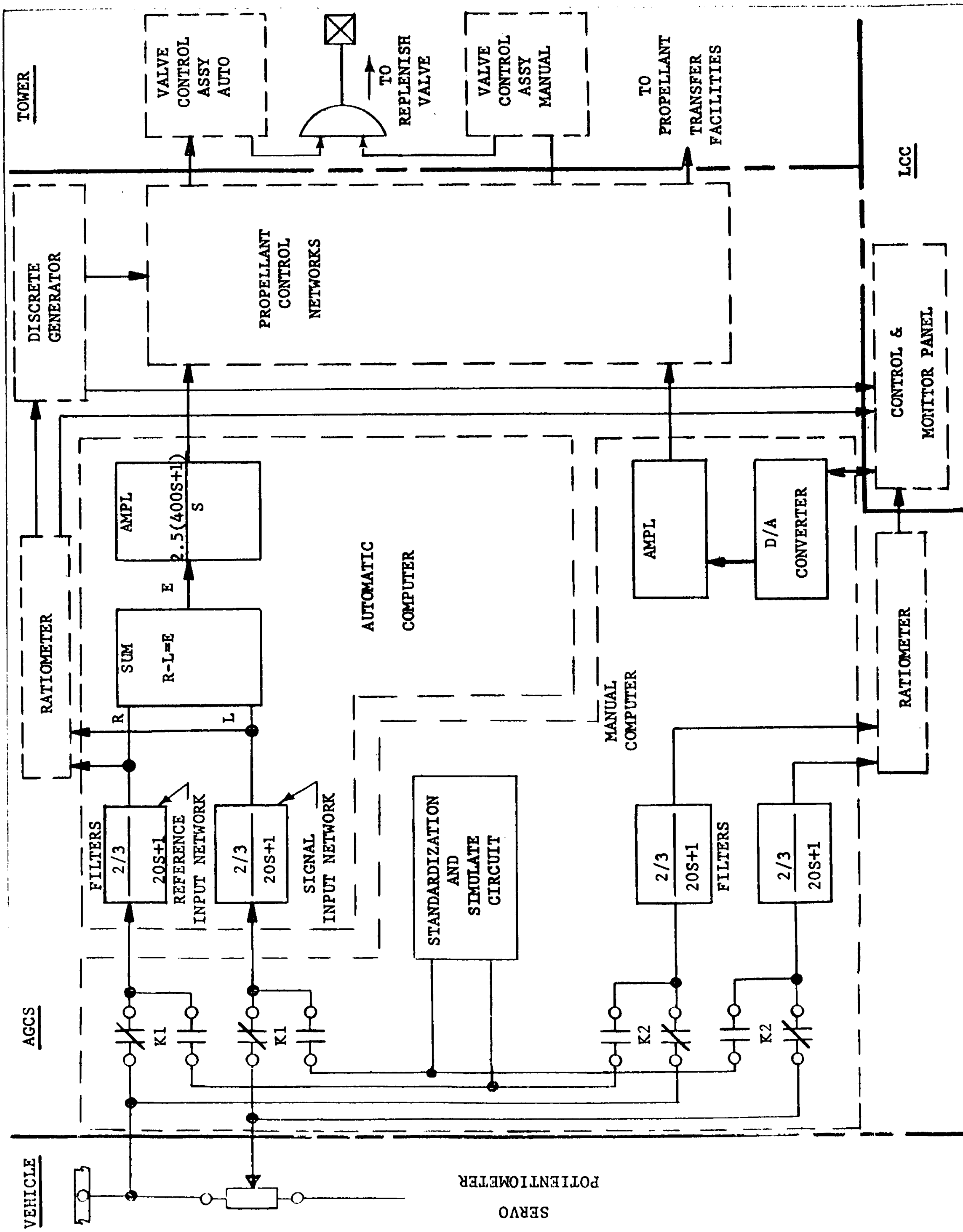


Figure 2-13. Functional Layout of the PTCS

the Control and Monitor Panel. The simulate-calibrate controls are located on the Control and Monitor Panel.

The filtered signals are fed into the Ratiometer. Here, they are converted into a digital signal with a numerical value equal to the propellant level in the tank, in percent.

The digital signal from the Ratiometer is then routed into the Discrete Generator. Its numerical value is compared against seven preset discrete values, which mark six specific points in the fueling cycle:

a. Start Fast Fill
b. Start Cold GHe Load
c. Stop Fast Fill
d. Replenish Normal
e. Stop Flow Fill
f. Flight Mass -
    1. Upper Limit
    2. Lower Limit

As each one of these specific points is reached, a circuit in the Discrete Generator is energized, transmitting this fact to the propellant control networks. An indicator on the Control and Monitor Panel is also energized to display each point of the loading cycle that has been completed.

The digital signal from the Ratiometer is also fed directly into the Control and Monitor panel. This panel, located in the LCC, displays the Ratiometer signal as a five digit number. (The panel, shown in figure 2-14, provides readout displays for both the automatic and manual modes.)

The automatic filling cycle for the propellant tanks, from chilldown to Flight Mass completion is a precisely organized sequence of events. The points at which activities are begun and terminated are related directly to the propellant level in the tanks, and commands to the transfer facilities are initiated in the propellant control networks by discrete signals received from the Discrete Generator.

A simplified block diagram showing a complete PTCS system and the location of its major units is presented in figure 2-15. It also demonstrates the cable sharing approach employed to reduce over-all cabling requirements.

For the S-IC, each PTCS receives two-part signals. Level indications up to 94.5% are provided by pressure transducers located at top and bottom of the tanks, and level indications from 94.5% to 100% are provided by capacitance probes. While the PTCS are still in final design, it is anticapated that the equipment will be modified, to employ pressure transducers during early fill, and transfer to the capacitor probe for final adjust. Figure 2-16 shows a block diagram for these PTCS.

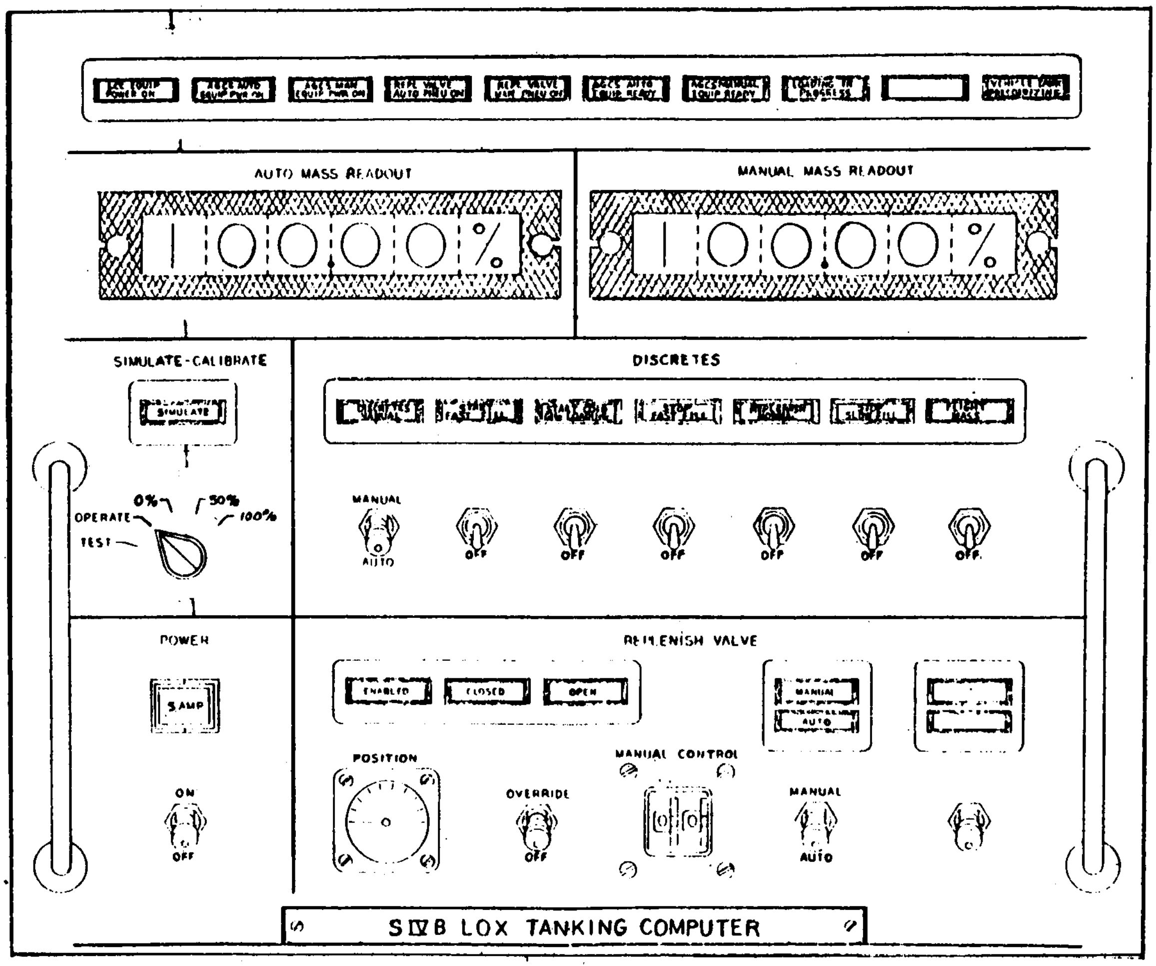


Figure 2-14. PTCS Control and Monitor Panel

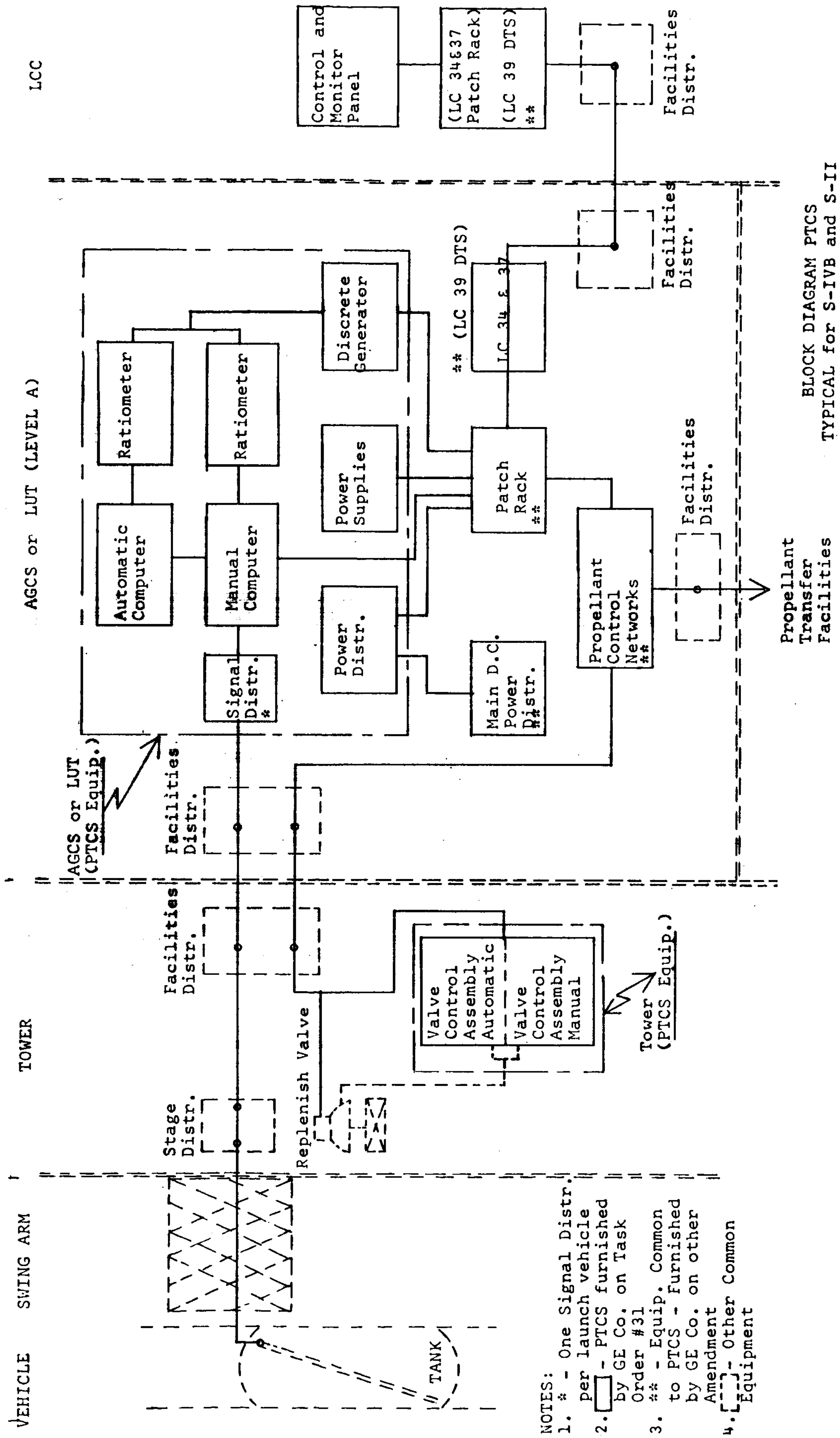


Figure 2-15. PTCS Block Diagram

2-13. Manual Operation. Normal operation of the PTCS is fully automatic. Unless some malfunction occurs, the operator at the control console simply observes the propellant loading operations. The PTCS design does, however, include a complete manual system, wired in parallel with the automatic installation described above. It provides an independent reference monitor during automatic operations and permits manual take-over at any point in the loading cycle.

The signals from the vehicle, described earlier, are fed through parallel filter networks into a Ratiometer exactly as in the automatic system. They are converted into a digital signal and fed into the Control and Monitor Panel, in this case for display on the manual readout portion of the panel.

Should any malfunction occur in the automatic channel, the operator can switch to manual mode on his panel and feed a controlled digital signal into a digital-analog converter. The analog output signal is then fed into an amplifier, and from there, to the manual Valve Control Assembly which is a duplicate of the unit in the automatic system. This controller, through a parallel pneumatic circuit, can also adjust the Replenish Valve to complete propellant loading.

The operator can, in addition, elect to introduce discrete signals into the propellant control networks, through operation of switches on the Control and Monitor panel. This permits him to provide manual substitution for the Discrete Generator.

2-14. EQUIPMENT LOCATION

All PTCS equipment is located in one of three places:

a. The LUT (Tower)
b. The (LUT Level "A" for LC-39)
c. The LCC

1. Tower. Equipment in the tower is limited to the automatic and manual Valve Control Assemblies, both of which are housed in a single cabinet.

2. LUT Level "A." PTCS components are packaged into a single rack for each system. Equipment for each PTCS includes two Ratiometers, two Computers, the Discrete Generator, a Power Supply, and a Power Distributor.

3. LCC. Equipment in the Launch Control Center will consist of one Control and Monitor Panel for each PTCS.

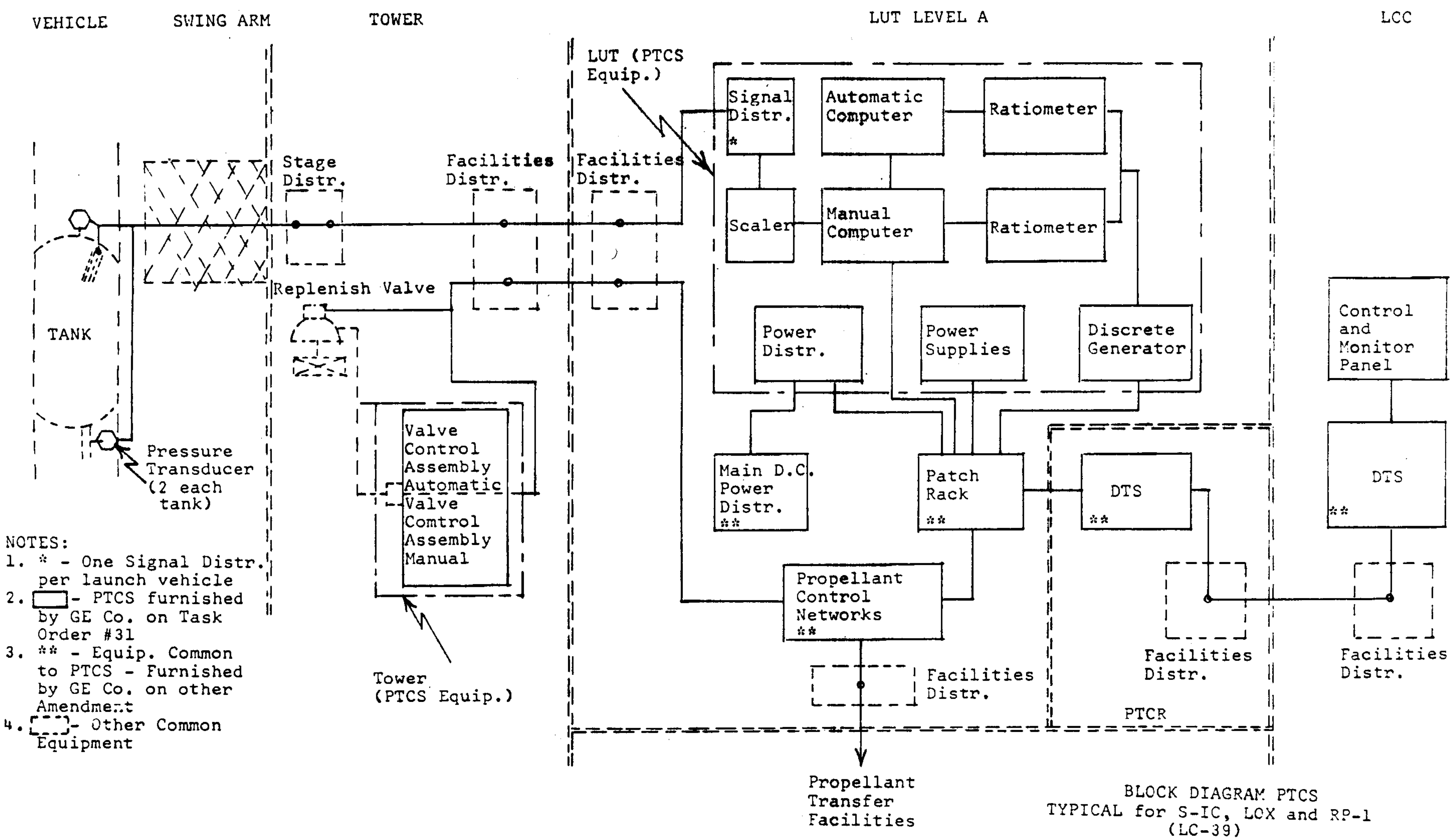


Figure 2-16. Block Diagram of PTCS Typical for S-IC, LOX and RP-1 (LC-39)

SECTION III
ENVIRONMENTAL CONTROL SYSTEM

3-1. GENERAL

The environmental control system supplies conditioned air or gaseous nitrogen (GN_2) for controlling the temperature in the various compartments in the Saturn V vehicle. Processed outdoor air is used as the temperature control medium in the early preparatory stages and GN_2 is used as a purging and temperature control medium in the final stages of the countdown period. The GN_2 conditioned purge will be initiated prior to tanking LOX.

The environmental control system is based on the following outside ambient conditions:

a. Summer
   95^o FDB 85^o FWB
b. Winter
   29^o FDB

Blower and coil assemblies supply the temperature control medium (air GN_2) to each compartment of the vehicle that is serviced from this system. Prefiltered outdoor air is pressurized approximately $2\frac{1}{2}$ pounds above atmospheric pressure, with moisture content reduced in passing through a cooling coils. Air is reheated as required by heating compartments. An arrangement of dampers and valves provides for the changeover from air to GN_2. The GN_2 is processed through the same temperature control coils. Air and GN_2 are supplied to the following locations:

a. Stage S-IC FWD, compartment instrument containers
b. Stage S-IC AFT, engine compartment
c. Stage S-II FWD, Compartment instrument containers
d. Stage S-II AFT, engine compartment
e. Stage S-II AFT, compartment instrument containers
f. Stage S-IVB AFT, interstage and engine compartment
g. Command Module
i. Service Module

3-2. Cooling. A chilled glycol-water solution is circulated to the cooling coils of the blower/coil units from a central storage tank. Three chiller units provide the cooling required to produce the prescribed temperature in the cooling solution storage tank. An outdoor water cooling tower is employed for the heat disposal from the condenser of the chiller units.

3-3. HEATING OF AIR SUPPLY

The air/GN_2 is heated to the required temperature with electric heaters controlled by silicon controlled rectifiers and/or saturated core reactors. Redundant heaters and power controllers are provided.

There are two air intakes in the ECS room furnishing air to the blowers. In addition to the air, GN_2 is supplied to the ECS room from the Converter- Compressor System. If the supply of air is lost during an operation due to a power outage, the GN_2 will enter the system and provide the environmental requirements to the launch vehicle. Operation of the ECS system is executed manually as is the adjustment of the system parameters prior to the launch countdown. Temperature is automatically controlled with a manual override control provided on each control panel.

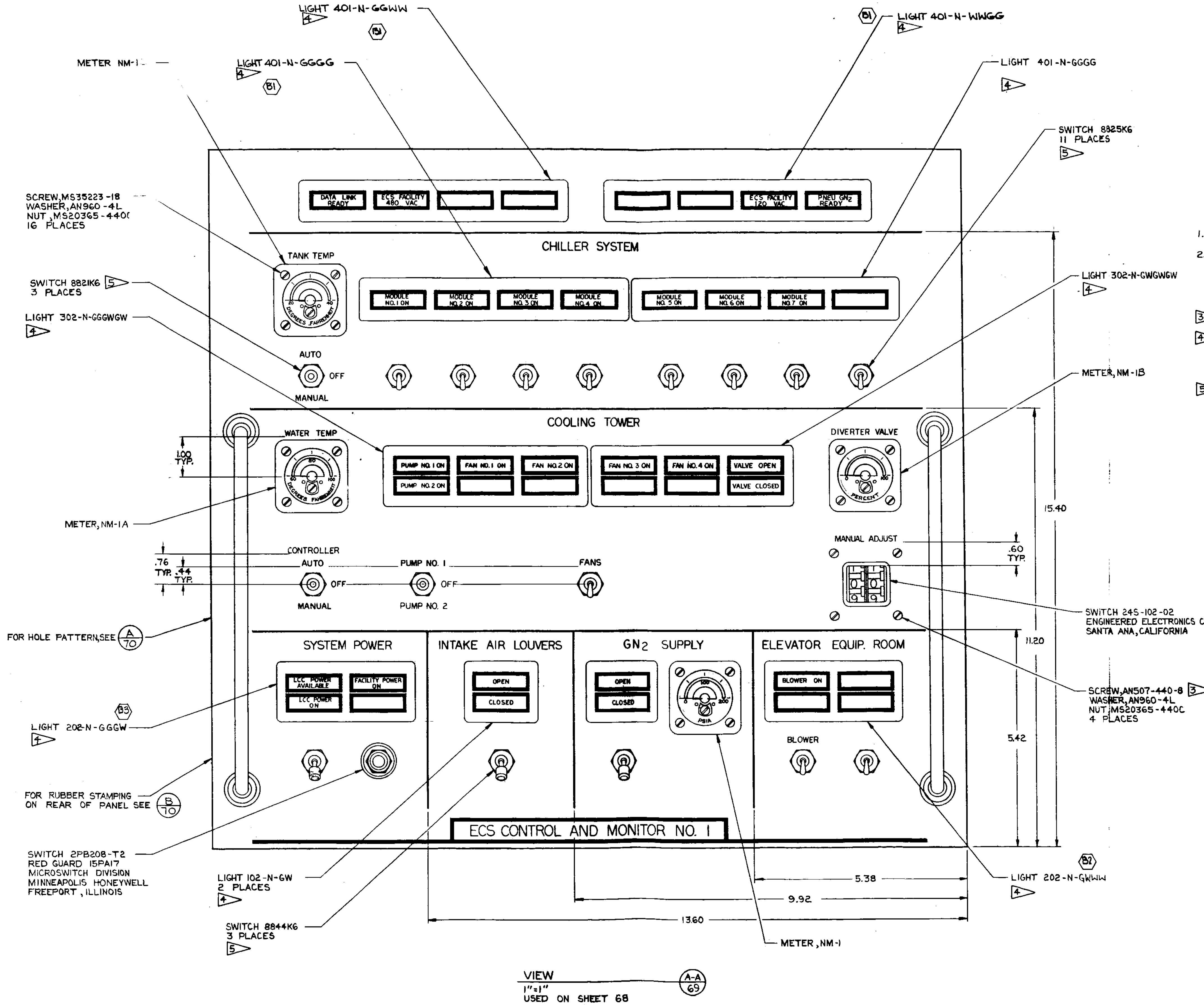
Located in each firing room of the LCC are five (5) ECS control and monitor panels. ECS control and monitor panels No. 1 and No. 2 monitor Data Link Ready, ECS facility voltage, GH_2 pneumatic ready, and control and monitor the Chiller System Cooling Tower, System Power, Intake GN_2 Supply. The chiller modules are provided with automatic and manual control, as are the diverter valves for the water system to the cooling towers. The panel face layout is given in figure 3-1 and 3-2.

Environment Control System vehicle control and monitor nos. 1, 2, and 3 panels monitor and control temperature, flow rates, and reheat for the various vehicle compartments or areas previously listed. Automatic or manual operation is provided for temperature control. The panel face layouts are given in figures 3-3 through 3-5.

Environmental Control System control and monitor signals are transmitted between the LCC and the ECS room via the Data Transmission System.

A simulator is provided to check out the system when the LUT is not at the pad. The simulator will electrically replace the LUT and launch vehicle for check out purposes.

The ECS electrical control interconnect diagrams showing the equipment locations and electrical interconnects are given in figures 3-6 and 3-7. The ECS power interconnect diagram is given in figure 3-8. The one-line power schematics are given in figures 3-9 through 3-11.



NOTES

1. ENGRAVE PANEL PER MSFC-STD-275
2. PRIOR TO ASSEMBLY, FINISH PANEL PER MIL-STD-171 (ORD), FINISH NO. 4.3 + 7.3 (ELECTRICALLY CONDUCTIVE) AND PAINT PANEL FRONT AND EDGES ONLY, PER SYSTEM 21.9, COLOR NO. 26440 (GRAY) OF FED-STD-595
3. FINISH SCREW HEADS TO MATCH PANEL
4. MASTER SPECIALTIES CO., GARDENA, CALIF. LEGEND TO BE ENGRAVED BY VENDOR USING UPPER CASE ALT. GOTHIC NO. 2 CHARACTERS .100 ±.010 HIGH
5. CUTLER HAMMER INC., MILWAUKEE, WISC.

Figure 3-1. ECS Control and Monitor Panel No. 1

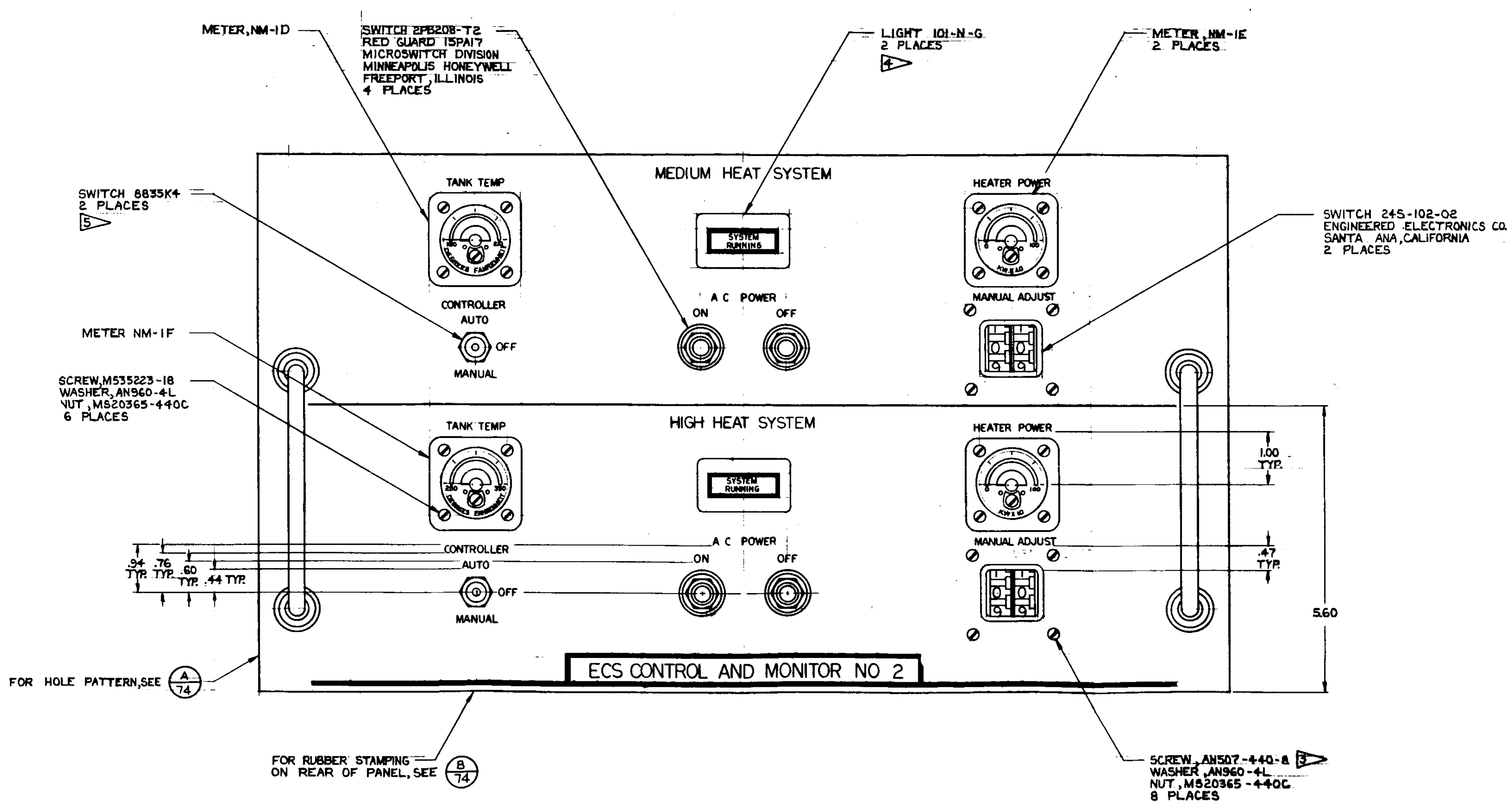


Figure 3-2. Fcs Control and Monitor Panel No. 2

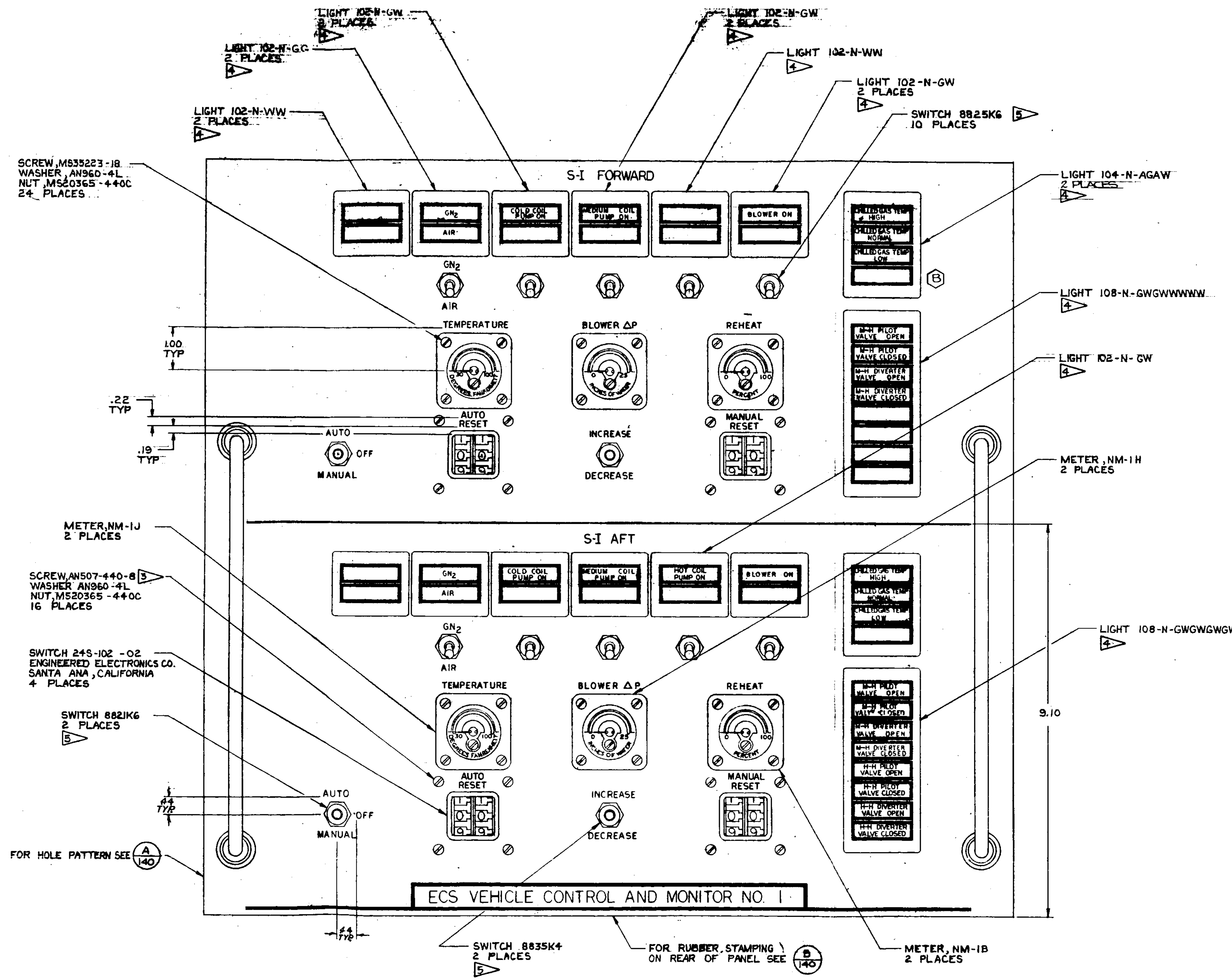


Figure 3-3. ECS Vehicle Control and Monitor No. (1)

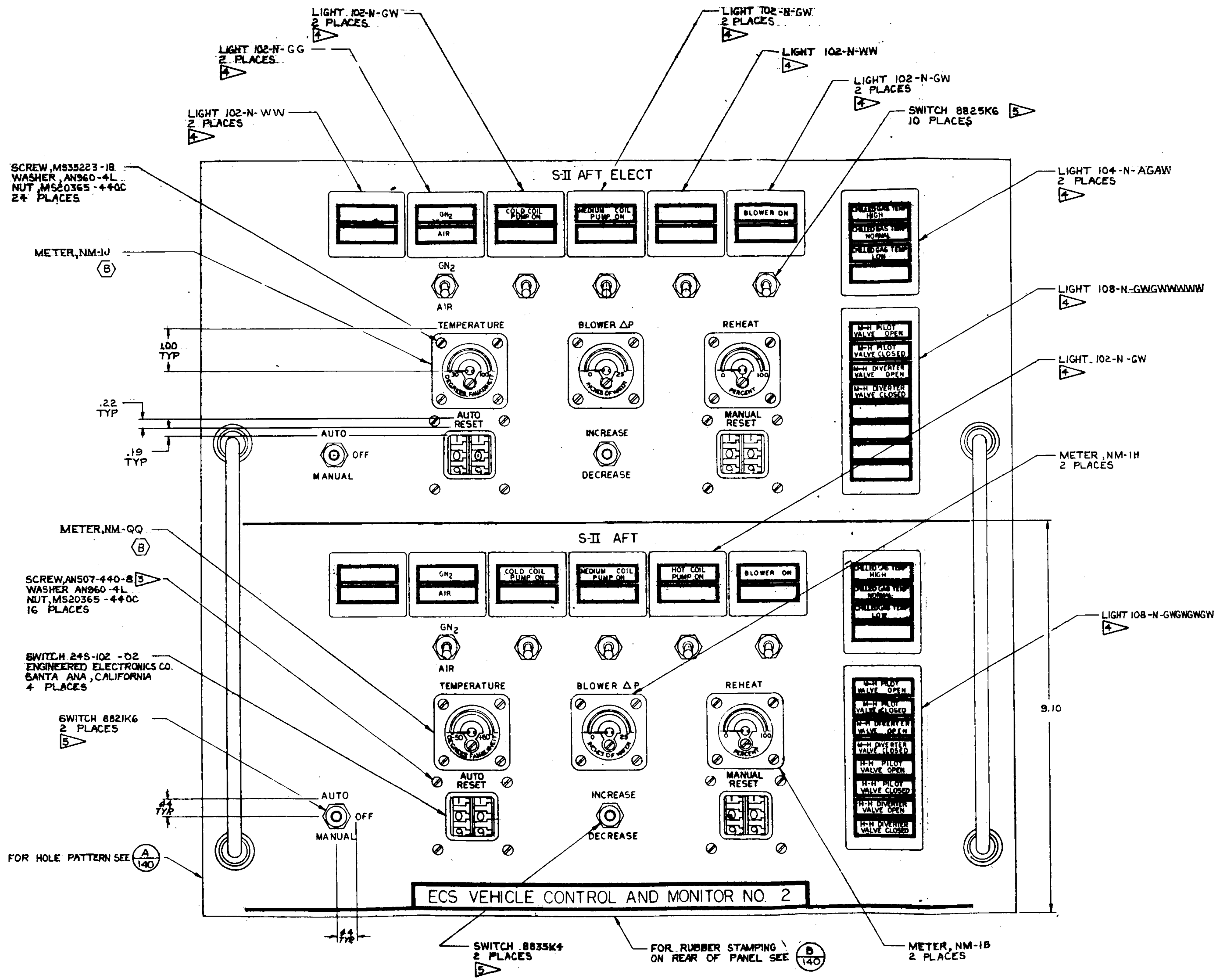


Figure 3-4. ECS Vehicle Control and Monitor No. (2)

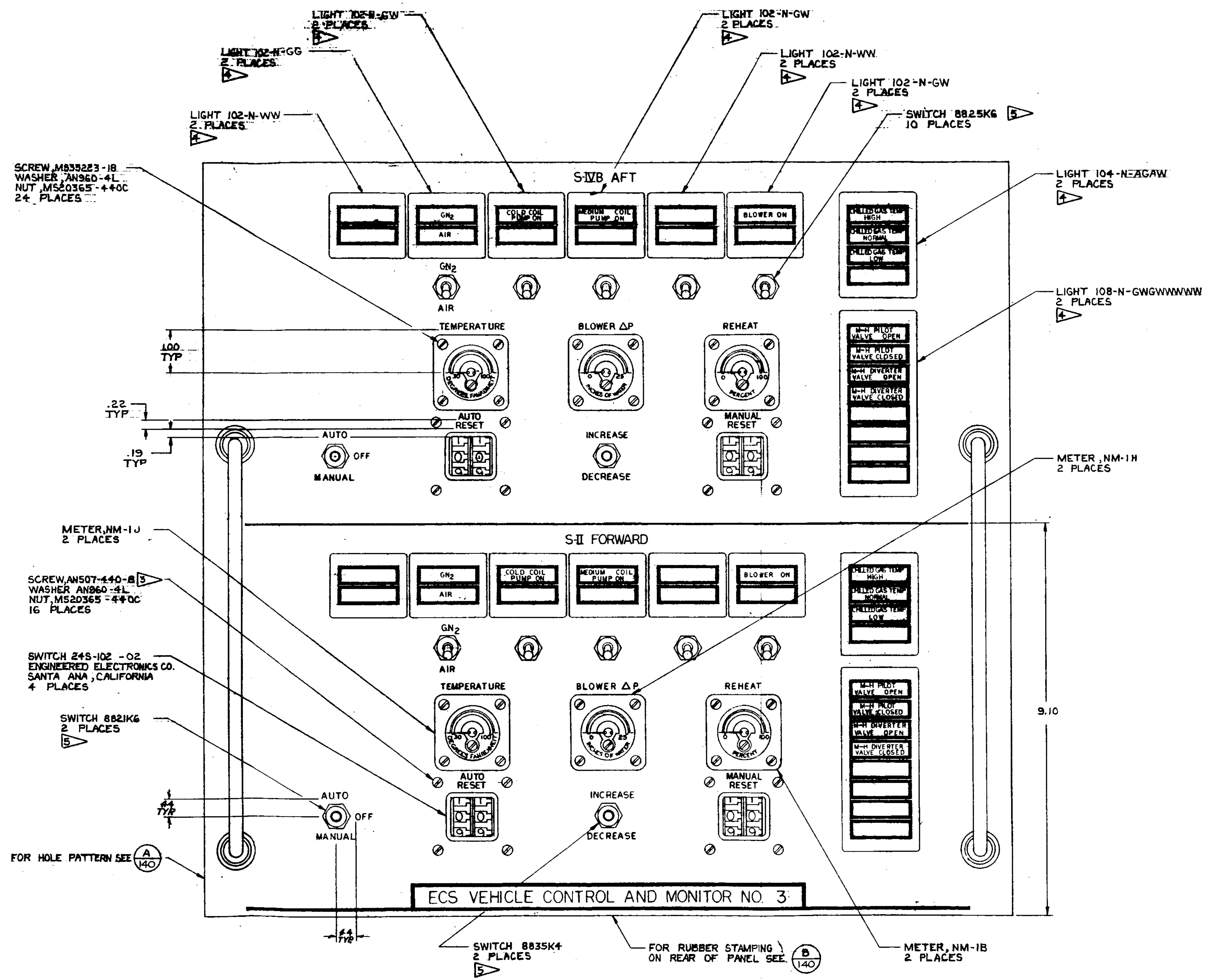


Figure 3-5. ECS Vehicle Control and Monitor No. (3)

Figure 3-6.

To Be Provided

Foldout

Figure 3-7.

To Be Provided

Foldout

Figure 3-8.

To Be Provided

Foldout

Figure 3-9.

To Be Provided

Foldout

Figure 3-10,

Foldout

To Be Provided

Figure 3-11.

Foldout

To Be Provided

SECTION IV
CONVERTER COMPRESSOR

4-1. GENERAL

The converter-compressor facility comprises a 500,000-gallon storage dewar, a tank vaporizer, six (6) high pressure LH_2 pump and vaporizer units, five high pressure helium compressor units, two 230-gpm liquid nitrogen pumps, one 230-gpm low pressure liquid nitrogen vaporizer, helium and nitrogen gas driers and purifiers, and associated equipment. The facility layout is given in figure 4-1. The system layout is given in figure 4-2.

4-2. DESCRIPTION

The converter-compressor facility converts liquid nitrogen to high pressure gaseous nitrogen. The high pressure GN_2 is delivered at 6,000 psi to the high pressure storage batteries at the launch pad and the VAB. The high pressure storage batteries supply the pneumatic systems for LC-39. GN_2 at 150 psi is also supplied directly to the ECS.

Gaseous helium is also supplied to the high pressure storage batteries from GHE Tube Bank Cars located at a railroad siding adjacent to the converter-compressor building. The helium pressure from the tube bank is increased to 6,000 psi by the six helium compressors located at the Converter-Compressor Building prior to delivery to the high pressure storage batteries.

The liquid nitrogen is converted to gaseous nitrogen in this system by means of the six (6) pump vaporizer units. Electrical control of the system is centered on a control panel which is an integral part of a control cabinet mounted on each of the pumping unit assemblies.

4-3. ELECTRICAL SYSTEM

The electrical system provides power for the 75-hp A-C pump motors, the 20-hp A-C vaporizer blower motors, the 100-hp A-C helium compressor motors, the 60-hp A-C LN_2 auxiliary low pressure pumps and their associated control circuits. The one-line power distribution schematics for the High Pressure Gas Converter facility are given in figures 4-3 and 4-4.

The electrical control and monitoring system layout showing the equipment locations and systems interconnect schematic for the LC-39 pneumatic system is given in figure 4-5.

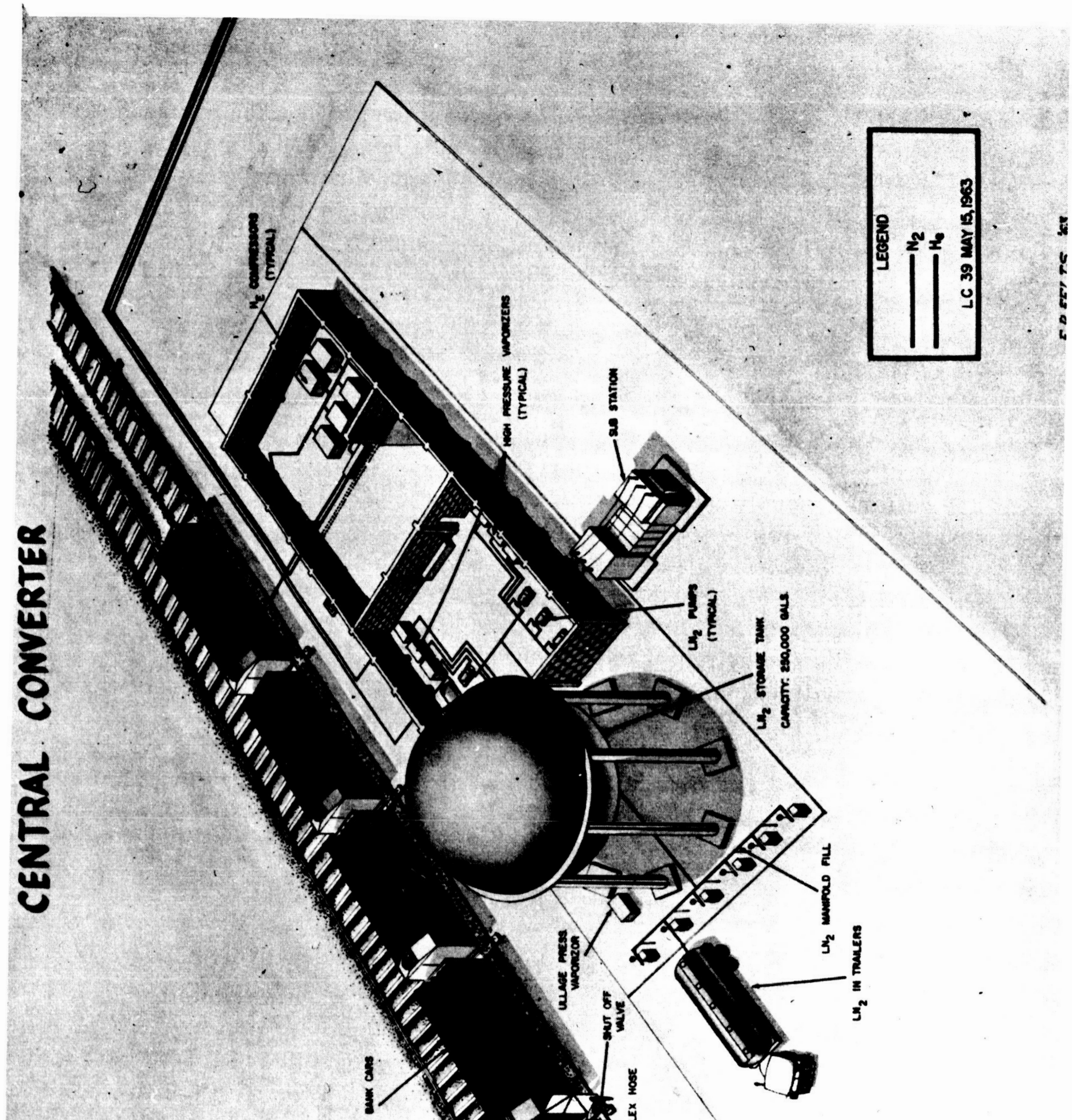


Figure 4-1. Converter Compressor Facility Layout

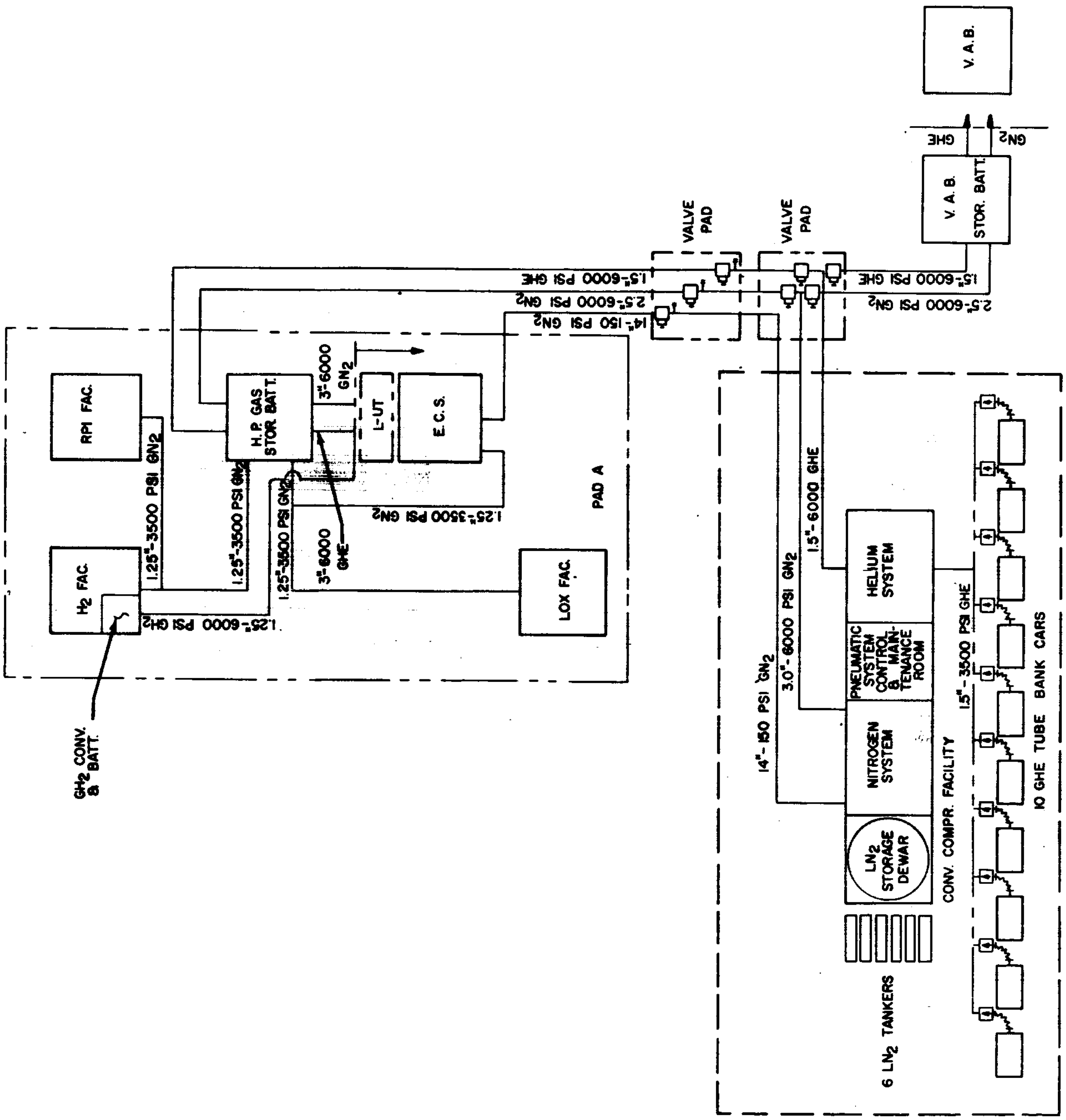


Figure 4-2. Converter Compressor System Layout

Figure 4-3.

Foldout

To Be Provided

Figure 4-4.

Foldout

To Be Provided

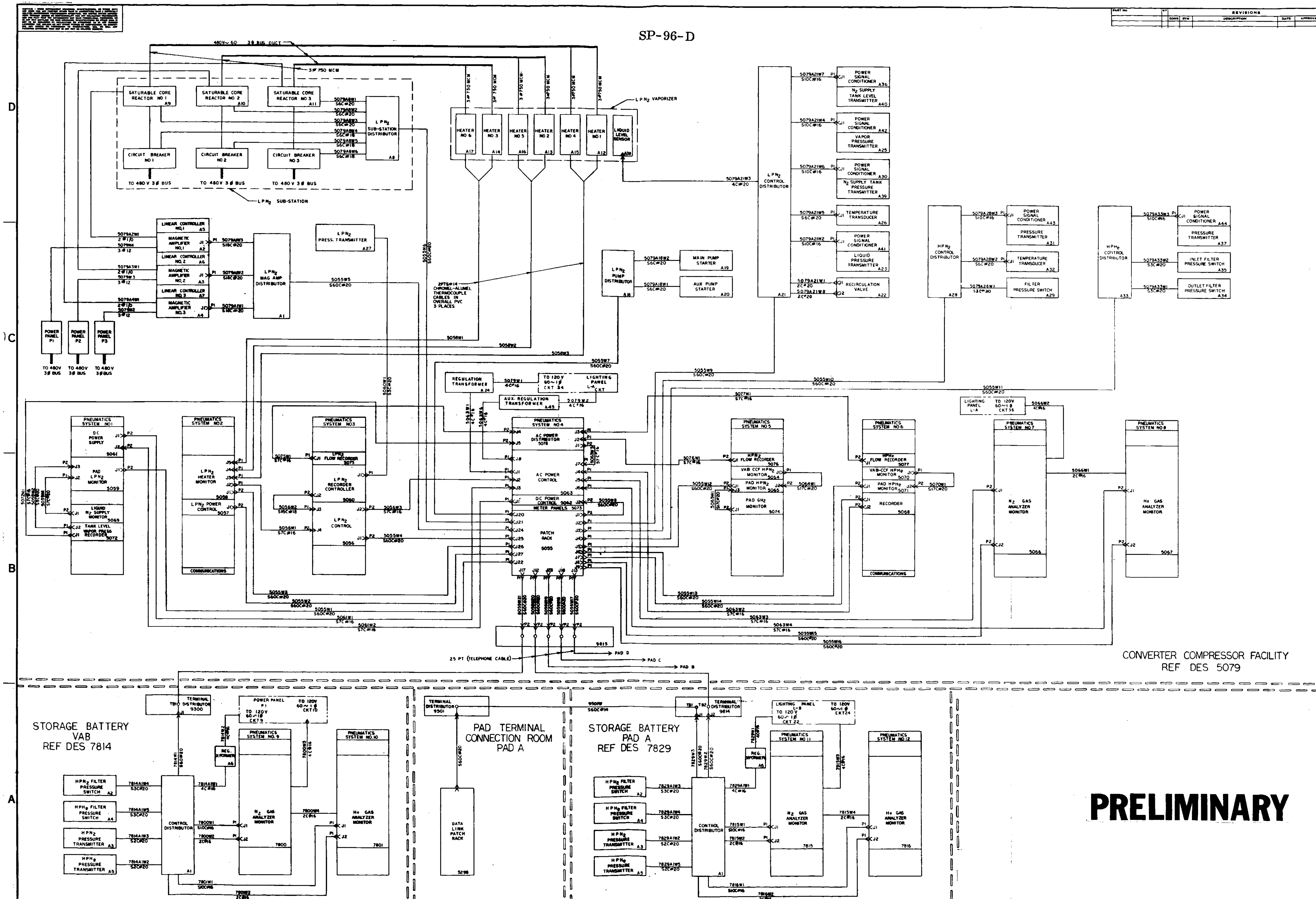


Figure 4-5. LC-39 Pneumatic System Equipment Location and Systems Interconnect Schematic

SECTION V
LAUNCHER UMBILICAL TOWER

5-1. GENERAL

The primary electrical power supplied to the LUT is divided into four seperate services as follows:

a. Instrumentation Power. Supplied at the LUT interface at 13.2 kv and routed to a substation located in room 16A. The substation consists of a 1000 kva dry-type transformer with a secondary output of 277/480 volts in a 3Ø Δ -Y, 4 wire system. Distribution of instrument power is made through a control switch board to a 277/480-volt power panel and a 480-120/208, 3Ø, dry-type distribution transformer. Instrumentation power is restricted to critical vehicle control, monitoring, safing, instrumentation circuits, and the flywheel motor-generator set which provides power to the RCA 110A computer.

b. Industrial Power. Supplied at the LUT interface at 13.2 kv and routed to a substation in room 16A. The substation consists of a 2500 kva dry-type transformer with a secondary output of 277/480 volts in a 3Ø, delta-grounded WYE system. Power distribution is made at 480 volts from a central industrial switch board to auxiliary power and lighting panel boards and 480-120/208 3Ø, distribution transformers as required. Switching facilities in the substation permit use of either power source as backup for the other.

c. Intransit Power. Supplied to the LUT from two (2) 150 KW diesel generator sets located in the crawler/transporter. The intransit power system is connected by automatic transfer switches to the industrial and instrumentation power systems on the LUT during transit from the VAB to the launch pad. The intransit power is used for the following items:

1. Air conditioning for the computer room.
2. Certain ventilating fans for the LUT.
3. Obstruction lights.
4. Elevator No. 2.
5. Service arm hydraulic unit.
6. Ground measuring data system normally from instrumentation power.

d. Emergency Power. Supplied to the LUT to provide power for emergency lighting, obstruction lights, one tower elevator, and the ground measuring data system. The emergency power system is a separate electrical network that is normally connected to the LUT industrial power system. Loss of industrial power automatically transfers the emergency power network to a 300 kw, emergency motor generator set located in the ground facilities.

5-2. ELECTRICAL POWER DISTRIBUTION NETWORK

The one-line power distribution diagram is given in figure 5-1. The power distribution networks are as follows:

a. Instrumentation Power is delivered from the Instrumentation Unit Substation to the various locations on the LUT shown in figure 5-1.

b. Industrial Power is delivered from the Industrial Unit Substation to the various Distribution panels on the LUT shown in figure 5-1.

Compartment locations on the LUT, Level A and B are given in figures 5-2 and 5-3. The feeder and cable schedule is given in figure 5-4.

5-3. INSTRUMENTATION, CONTROL, COMMUNICATIONS AND OPERATIONS TV CABLE DISTRIBUTION NETWORKS

The networks for the Measuring Coax Terminal Distribution System, the Measuring Acquisition Terminal Distributor System and the Service Arm M1 Terminal Distributor System are shown in the one-line diagram of the M1 Tower Firing and Pad Measuring Systems in figure 5-5.

Riser diagrams of the Sound Power Telephone System, Operational Intercommunication System, Countdown and Control System, and the Operational TV System are given in figure 5-6.

One-line diagrams of the permanent Base Communication System, Base Paging System, and Intercom Telephone System are given in figure 5-7.

One-line diagrams of the Stage Oriented Cable Facilities consisting of the UB Instrumentation Cable Facilities and the UB Power Cable Facilities are given in figure 5-8.

Riser diagrams of the TV lighting and Camera Power and Control Systems are given in figure 5-9.

A one-line diagram of the Umbilical Tower Remote Welding Facilities is given in figure 5-10.

A one-line diagram of the Fire Alarm System is given in figure 5-11.

5-4. PNEUMATIC CONTROL SYSTEM

The pneumatic control system provides the control and monitoring functions for the gas pressures and control valve positions for the GN_2 and helium

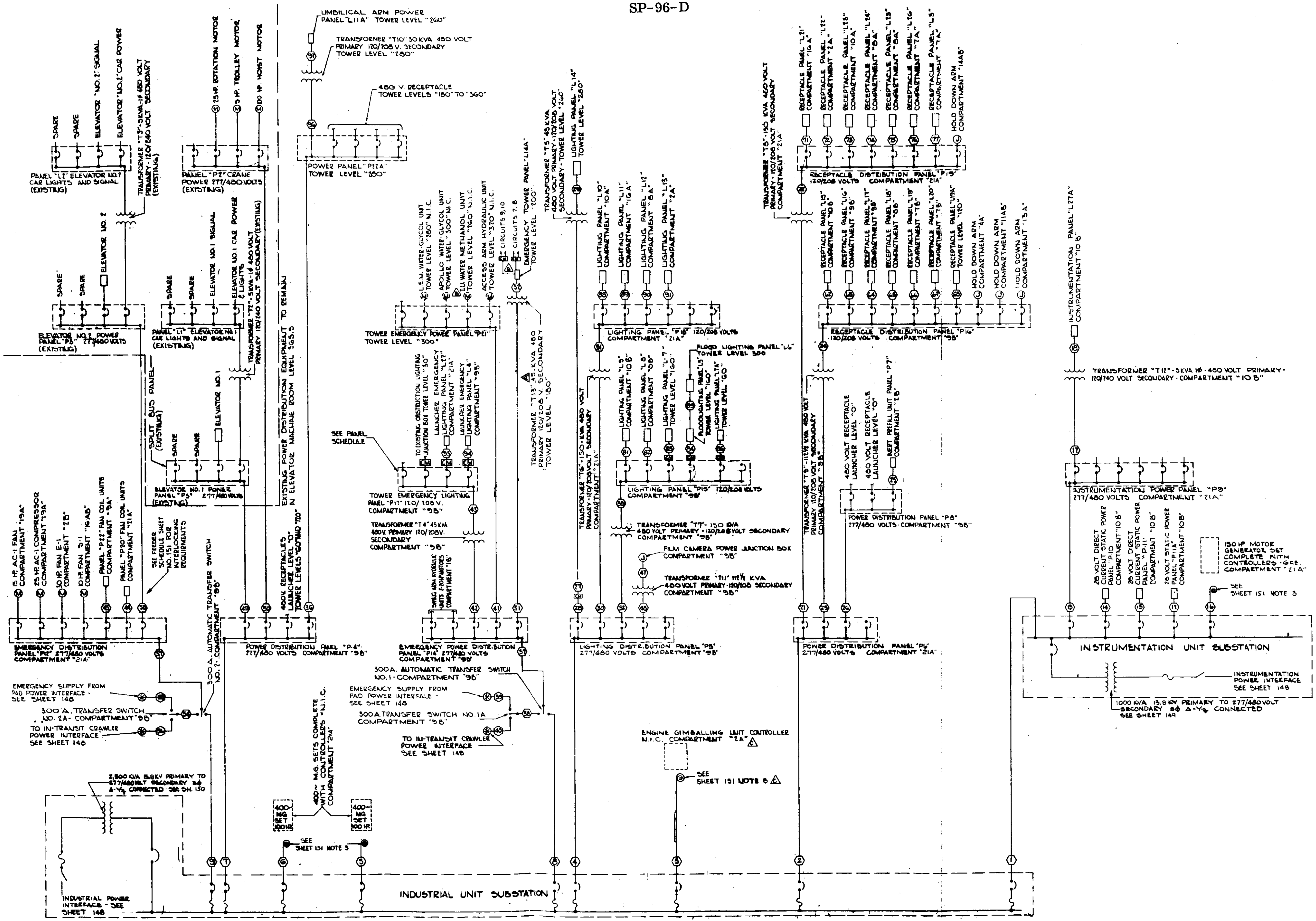


Figure 5-1. One-Line Power Distribution Diagram

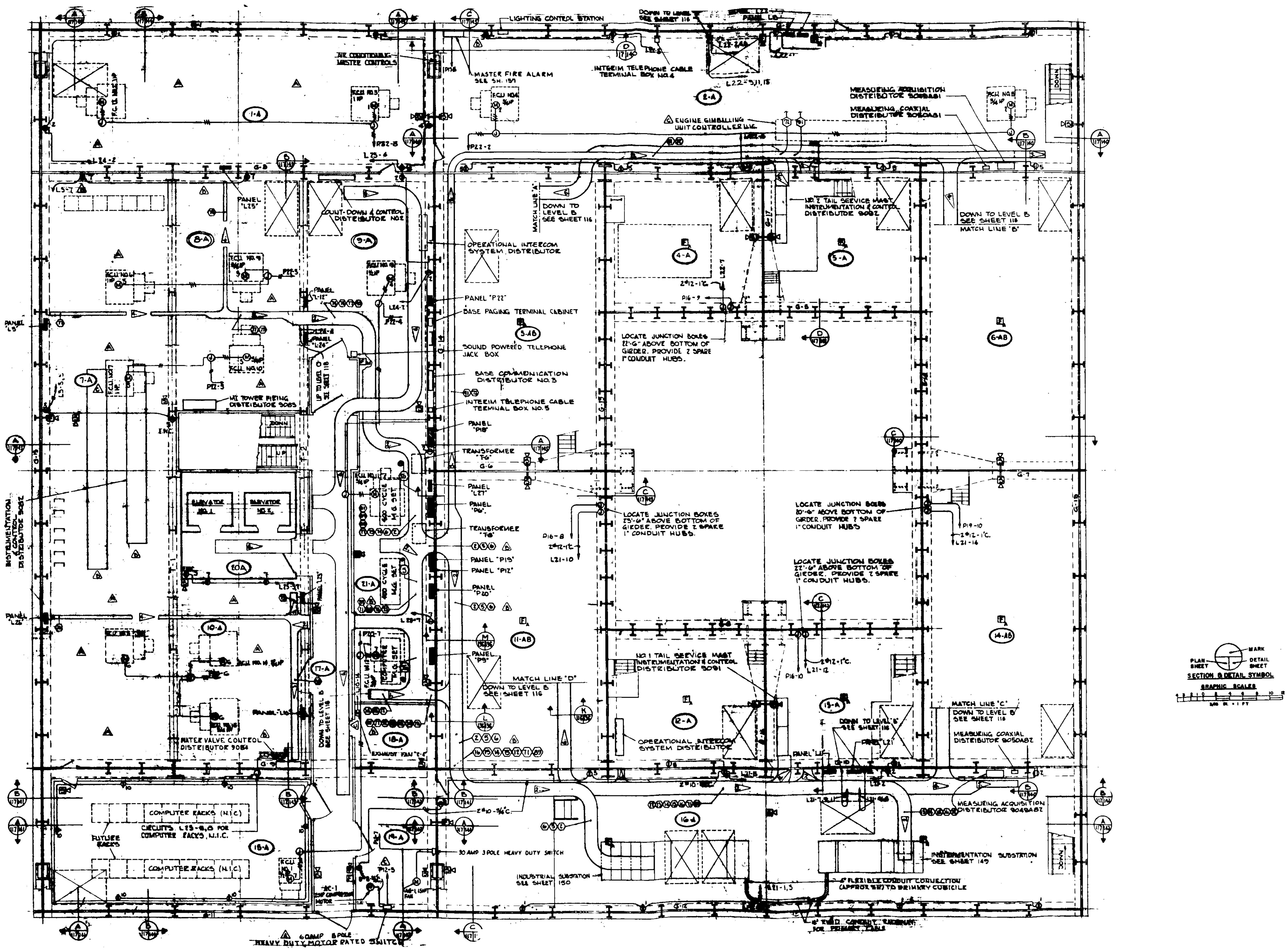


Figure 5-2. Compartment Locations on the LUT, Level A

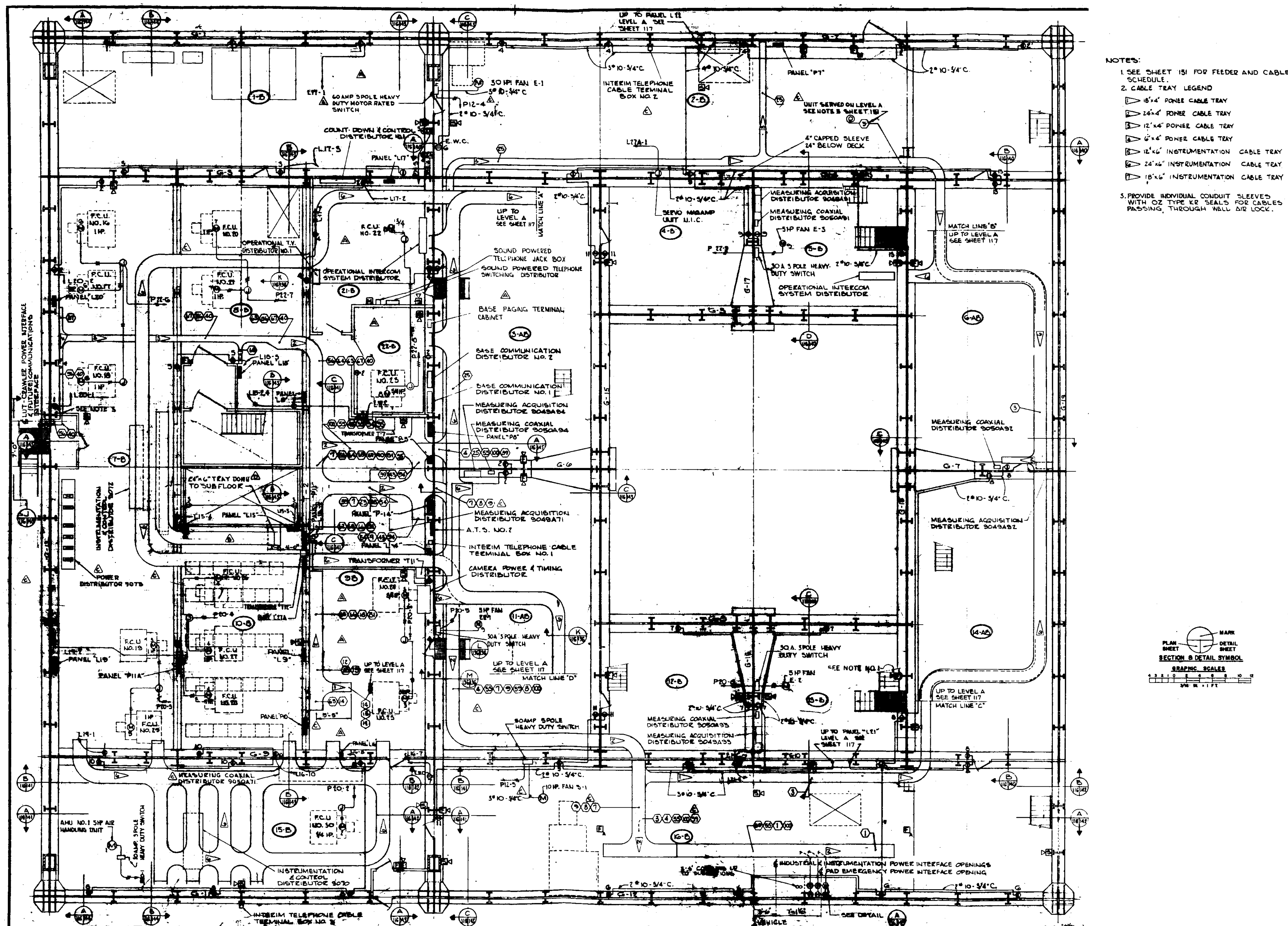
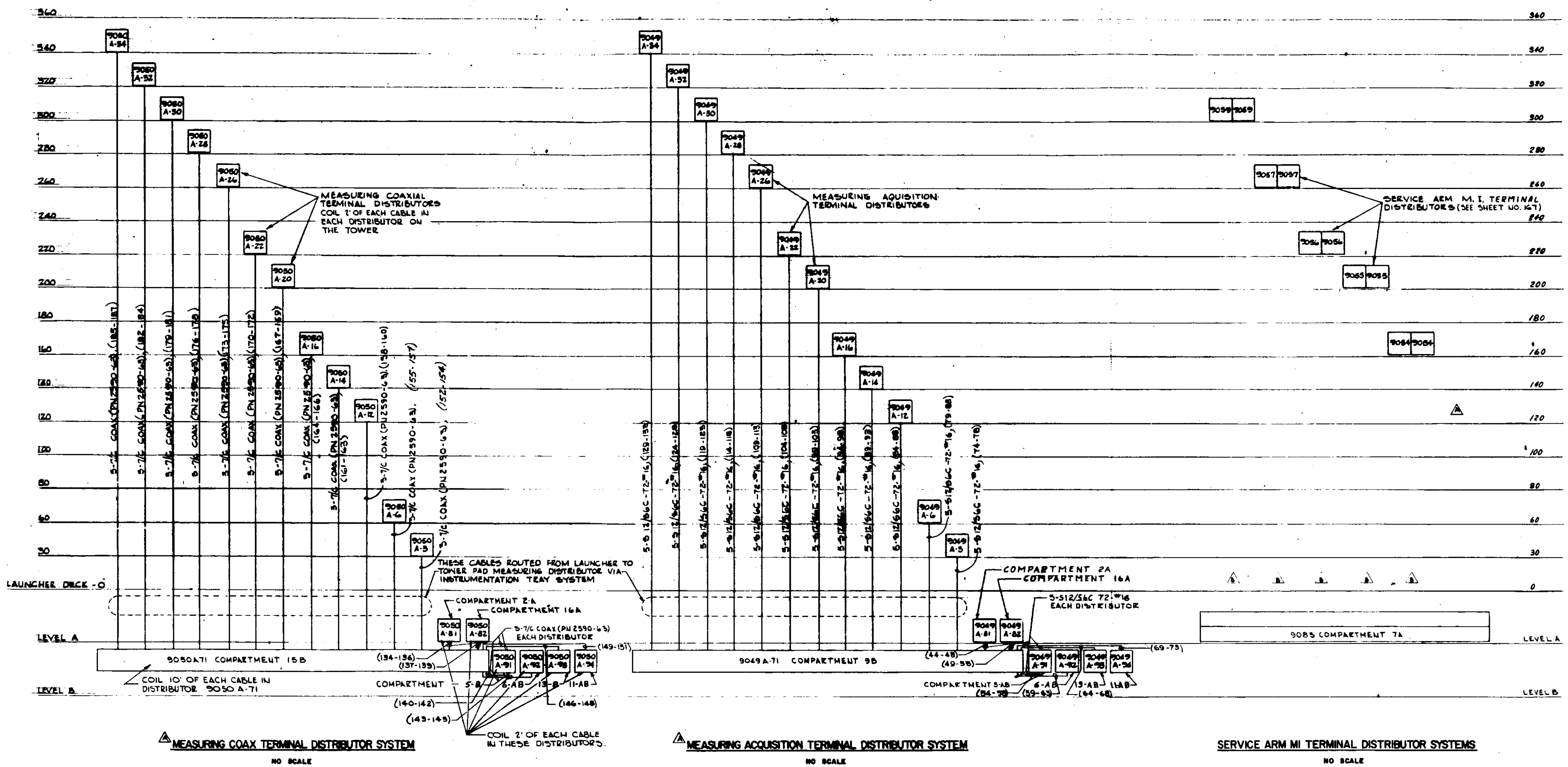


Figure 5-3. Compartment Locations on the LUT, Level B

CIRCUIT DESIG.	FUNCTION	FROM	TO	CONDUCTORS			TYPE	REMARKS
				NO.	SIZE	TYPE	RACEWAY	
1	TIE FEEDER	INDUSTRIAL SUBSTATION	INSTRUMENTATION SUBSTATION	SEE IND. SWBD. SCHED.-SHEET-149/150				
2	PANEL "P6" MAIN FEEDER	INDUSTRIAL SUBSTATION	PANEL "P6"	SEE IND. SWBD. SCHED.-SHEET-150				
3	ENGINE GIMBALLING FEEDER	INDUSTRIAL SUBSTATION	ENGINE GIMBALLING UNIT G.F.E.	SEE IND. SWBD. SCHED.-SHEET-150				NOTE 5
4	TOWER LIGHTING AND POWER FEEDER	INDUSTRIAL SUBSTATION	PANEL "P5"	SEE IND. SWBD. SCHED.-SHEET-150				
5	400 C.P.S. POWER SOURCE	INDUSTRIAL SUBSTATION	400 C.P.S. M-G. SET G.F.E.	SEE IND. SWBD. SCHED.-SHEET-150				NOTE 5
6	400 C.P.S. POWER SOURCE	INDUSTRIAL SUBSTATION	400 C.P.S. M-G. SET G.F.E.	SEE IND. SWBD. SCHED.-SHEET-150				NOTE 5
7	CRANE AND ELEVATOR SYSTEM	INDUSTRIAL SUBSTATION	PANEL "P4"	SEE IND. SWBD. SCHED.-SHEET-150				
8	NORMAL SOURCE EMERGENCY POWER	INDUSTRIAL SUBSTATION	AUTOMATIC TRANSFER SWITCH NO.1	SEE IND. SWBD. SCHED.-SHEET-150				
9	NORMAL SOURCE EMERGENCY POWER	INDUSTRIAL SUBSTATION	AUTOMATIC TRANSFER SWITCH NO.2	SEE IND. SWBD. SCHED.-SHEET-150				
10	NUMBER NOT USED							
11	NUMBER NOT USED							
12	28 VOLT D.C. POWER SUPPLIES	INSTRUMENTATION SUBSTATION	PANEL "P11A"	SEE PANEL SCHED.-SHEET-152				
13	INSTRUMENTATION POWER FEEDER (480V)	INSTRUMENTATION SUBSTATION	PANEL "P9"	SEE INST. SWBD. SCHED.-SHEET-149				
14	28 VOLT D.C. POWER SUPPLIES	INSTRUMENTATION SUBSTATION	PANEL "P10"	SEE INST. SWBD. SCHED.-SHEET-149				
15	28 VOLT D.C. POWER SUPPLIES	INSTRUMENTATION SUBSTATION	PANEL "P11"	SEE INST. SWBD. SCHED.-SHEET-149				
16	COMPUTER POWER 480 V. FEEDER	INSTRUMENTATION SUBSTATION	COMPUTER M-G SET G.F.E.	SEE INST. SWBD. SCHED.-SHEET-149				NOTE 5
17	INSTRUMENTATION POWER FEEDER (480V)	PANEL "P9"	TRANSFORMER "T12"	SEE PANEL SCHED.-SHEET-152				
18	INSTRUMENTATION POWER FEEDER (120/240V.)	TRANSFORMER "T12"	PANEL "L27A"	3	#6	RHW	1	
19	NUMBER NOT USED							
20	NUMBER NOT USED							
21	RECEPTACLES - 480 V. MAIN FEEDER	PANEL "P6"	TRANSFORMER "T8"	SEE PANEL SCHED.-SHEET-152				
22	RECEPTACLE PANEL FEEDER (120/208V.)	TRANSFORMER "T8"	PANEL "P19"	8	250 MCM	RHW	4	
23	RECEPTACLES - 480 V. MAIN FEEDER	PANEL "P6"	TRANSFORMER "T9"	SEE PANEL SCHED.-SHEET-152				
24	RECEPTACLE PANEL FEEDER (120/208V.)	TRANSFORMER "T9"	PANEL "P16"	4	500 MCM	RHW	3½	
25	PANEL PT FEEDER (480V.)	PANEL "P8"	PANEL "PT"	SEE PANEL SCHED.-SHEET-152				
26	LAUNCHER RECEPTACLE (480V.)	PANEL "P6"	PANEL "P8"	SEE PANEL SCHED.-SHEET-152				
27	TOWER LIGHTING	MAGNETIC CONTACTOR	TRANSFORMER "T5"	3-1C	2/0	MI		
28	TOWER LIGHTING FEEDER (480V.)	PANEL "P5"	MAGNETIC CONTACTOR	SEE PANEL SCHED.-SHEET-152				
29	TOWER LIGHTING FEEDER (120/208V.)	TRANSFORMER "T5"	PANEL "LT4"	4-1C	1/0	MI		
30	LEVEL "A" LIGHTING FEEDER (480V.)	PANEL "P8"	TRANSFORMER "T6"	SEE PANEL SCHED.-SHEET-152				
31	LEVEL "A" LIGHTING FEEDER (120/208V.)	TRANSFORMER "T6"	PANEL "P18"	8	250 MCM	RHW	4	
32	LEVEL "B" LIGHTING FEEDER (480V.)	PANEL "P5"	TRANSFORMER "T7"	SEE PANEL SCHED.-SHEET-152				
33	LEVEL "B" LIGHTING FEEDER (120/208V.)	TRANSFORMER "T7"	PANEL "P15"	8	250 MCM	RHW	4	TOWER LIGHTING & FLOOD LIGHTING
34	NUMBER NOT USED							
35	NUMBER NOT USED							
36	TOWER RECEPTACLE PANEL (480V.)	PANEL "P4"	PANEL "P22A"	SEE PANEL SCHED.-SHEET-153				
37	EMERGENCY POWER FEEDER	AUTOMATIC TRANSFER SWITCH NO.1	PANEL "P14"	1-4C	350 MCM		NOTE 1	⚠
38	EMERGENCY POWER FEEDER	AUTOMATIC TRANSFER SWITCH NO.1	AUTOMATIC TRANSFER SWITCH NO.1A	1-3C	350 MCM		NOTE 1	
39	EMERGENCY POWER SOURCE	AUTOMATIC TRANSFER SWITCH NO.1A	PAD EMERGENCY POWER INTERFACE	1-3C	350 MCM		NOTE 1	
40	"IN-TRANSIT" POWER SOURCE	AUTOMATIC TRANSFER SWITCH NO.1A	"IN-TRANSIT" POWER INTERFACE	1-3C	250 MCM		NOTE 1	
41	UPPER STAGES E.C.S. AND RECEPTACLES	PANEL "P14"	PANEL "P21"	SEE PANEL SCHED.-SHEET-153				
42	EMERGENCY LIGHTING FEEDER (480V.)	PANEL "P14"	TRANSFORMER "T4"	SEE PANEL SCHED.-SHEET-153				
43	EMERGENCY LIGHTING FEEDER (120/208V.)	TRANSFORMER "T4"	PANEL "P17"	1-4C	250 MCM		NOTE 1	⚠
44	LAUNCHER AIR CONDITIONING	PANEL "P12"	PANEL "P20"	SEE PANEL SCHED.-SHEET-152				
45	LAUNCHER AIR CONDITIONING	PANEL "P12"	PANEL "P22"	SEE PANEL SCHED.-SHEET-152				
46	NUMBER NOT USED							
47	FILM CAMERA POWER	TRANSFORMER "T11"	JUNCTION BOX	4	350 MCM	RHW	3½	
48	FILM CAMERA POWER	PANEL "P5"	TRANSFORMER "T11"	SEE PANEL SCHED.-SHEET-152				
49	EXISTING ELEVATOR NO.1 FEEDER	PANEL "P4"	EXISTING PANEL "P3"	SEE PANEL SCHED.-SHEET-152				NOTE 2
50	EXISTING CRANE FEEDER	PANEL "P4"	EXISTING PANEL "P2"	SEE PANEL SCHED.-SHEET-152				NOTE 2
51	TOWER EMERGENCY POWER (480V.)	PANEL "P14"	TRANSFORMER "T13"	SEE PANEL SCHED.-SHEET-153				
52	TOWER EMERGENCY POWER (120/208V.)	TRANSFORMER "T13"	PANEL "L16A"	3-1C	#2	MI		
53	NUMBER NOT USED							
54	EMERGENCY POWER FEEDER	AUTOMATIC TRANSFER SWITCH NO.2	AUTOMATIC TRANSFER SWITCH NO.2A	1-3C	350 MCM		NOTE 1	
55	EMERGENCY POWER SOURCE	AUTOMATIC TRANSFER SWITCH NO.2A	PAD EMERGENCY POWER INTERFACE	1-3C	350 MCM		NOTE 1	
56	"IN-TRANSIT" POWER SOURCE	AUTOMATIC TRANSFER SWITCH NO.2A	"IN-TRANSIT" POWER INTERFACE	1-3C	250 MCM		NOTE 1	
57	EMERGENCY POWER FEEDER	AUTOMATIC TRANSFER SWITCH NO.2	PANEL "P12"	1-4C	350 MCM		NOTE 1	⚠
58	ELEVATOR NO. 2 POWER FEEDER	PANEL "P12"	EXISTING PANEL "P3"	SEE PANEL SCHED.-SHEET-152				NOTES 2 & 4
59	NUMBER NOT USED							
60	NUMBER NOT USED							
61	NUMBER NOT USED							
62	RECEPTACLE PANEL FEEDER	PANEL "P16"	PANEL "L15"	SEE PANEL SCHED.-SHEET-153				
63	RECEPTACLE PANEL FEEDER	PANEL "P16"	PANEL "L16"	SEE PANEL SCHED.-SHEET-153				
64	RECEPTACLE PANEL FEEDER	PANEL "P16"	PANEL "L17"	SEE PANEL SCHED.-SHEET-153				
65	RECEPTACLE PANEL FEEDER	PANEL "P16"	PANEL "L18"	SEE PANEL SCHED.-SHEET-153				
66	RECEPTACLE PANEL FEEDER	PANEL "P16"	PANEL "L19"	SEE PANEL SCHED.-SHEET-153				
67	RECEPTACLE PANEL FEEDER	PANEL "P16"	PANEL "L20"	SEE PANEL SCHED.-SHEET-153				
68	RECEPTACLE PANEL FEEDER	PANEL "P16"	PANEL "L19A"	SEE PANEL SCHED.-SHEET-153				
69	NUMBER NOT USED							
70	NUMBER NOT USED							
71	RECEPTACLE PANEL FEEDER	PANEL "P19"	PANEL "L21"	SEE PANEL SCHED.-SHEET-153				
72	RECEPTACLE PANEL FEEDER	PANEL "P19"	PANEL "L22"	SEE PANEL SCHED.-SHEET-153				
73	RECEPTACLE PANEL FEEDER	PANEL "P19"	PANEL "L23"	SEE PANEL SCHED.-SHEET-153				
74	RECEPTACLE PANEL FEEDER	PANEL "P19"	PANEL "L24"	SEE PANEL SCHED.-SHEET-153				
75	RECEPTACLE PANEL FEEDER	PANEL "P19"	PANEL "L25"	SEE PANEL SCHED.-SHEET-153				
76	RECEPTACLE PANEL FEEDER	PANEL "P19"	PANEL "L26"	SEE PANEL SCHED.-SHEET-153				
77	RECEPTACLE PANEL FEEDER	PANEL "P19"	PANEL "L5"	SEE PANEL SCHED.-SHEET-153				
78	NUMBER NOT USED							
79	NUMBER NOT USED							
80	NUMBER NOT USED							

CIRCUIT DESIG.	FUNCTION	FROM	TO	CONDUCTORS			TYPE	REMARKS
				NO.	SIZE	TYPE	RACEWAY	
81	LAUNCHER LIGHTING PANEL FEEDER	PANEL "P15"	PANEL "L9"	SEE PANEL SCHED.-SHEET 153				
82	LAUNCHER LIGHTING PANEL FEEDER	PANEL "P15"	PANEL "L8"	SEE PANEL SCHED.-SHEET-153				
83	LAUNCHER LIGHTING PANEL FEEDER	PANEL "P18"	PANEL "L7"	SEE PANEL SCHED.-SHEET-153				
84	TOWER FLOODLIGHTING PANEL FEEDER	PANEL "P15"	PANEL "L5"	SEE PANEL SCHED.-SHEET-153				
85	TOWER FLOODLIGHTING PANEL FEEDER	PANEL "L5"	PANEL "L6"	SEE PANEL SCHED.-SHEET-154				
86	TOWER LIGHTING	PANEL "P15"	PANEL "L7A"	SEE PANEL SCHED.-SHEET-153				
87	NUMBER NOT USED							
88	LAUNCHER LIGHTING PANEL FEEDER	PANEL "P18"	PANEL "L10"	SEE PANEL SCHED.-SHEET-153				
89	LAUNCHER LIGHTING PANEL FEEDER	PANEL "P18"	PANEL "L11"	SEE PANEL SCHED.-SHEET-153				
90	LAUNCHER LIGHTING PANEL FEEDER	PANEL "P18"	PANEL "L12"	SEE PANEL SCHED.-SHEET-153				
91	LAUNCHER LIGHTING PANEL FEEDER	PANEL "P18"	PANEL "L13"	SEE PANEL SCHED.-SHEET 153				
92	NUMBER NOT USED							
93	NUMBER NOT USED							
94	LAUNCHER EMERGENCY LIGHTING FEEDER	PANEL "P17"	PANEL "L4"	SEE PANEL SCHED.-SHEET-153				
95	LAUNCHER EMERGENCY LIGHTING FEEDER	PANEL "P17"	PANEL "L27"	SEE PANEL SCHED.-SHEET-153				
96	TOWER RECEPTACLE PANEL FEEDER (480V.)	PANEL "P22A"	TRANSFORMER "T10"	SEE PANEL SCHED.-SHEET-153				
97	TOWER RECEPTACLE PANEL FEEDER (120/208V.)	TRANSFORMER "T10"	PANEL "L11A"	3-1/C	#2	MI CABLE		
98	NUMBER NOT USED							
99	NUMBER NOT USED							
100	VEHICLE FLOODLIGHTING	PAD POWER INTERFACE	PANEL "P15"	2-3/C	350 MCM		NOTE 1	

Figure 5-4. Feeder and Cable Schedule



NOTES:
1SEE SPECS. FOR IDENTIFICATION REQUIREMENTS OF CABLES.

Figure 5-5. One-Line Diagram of the M1 Tower Firing and Pad Measuring Systems

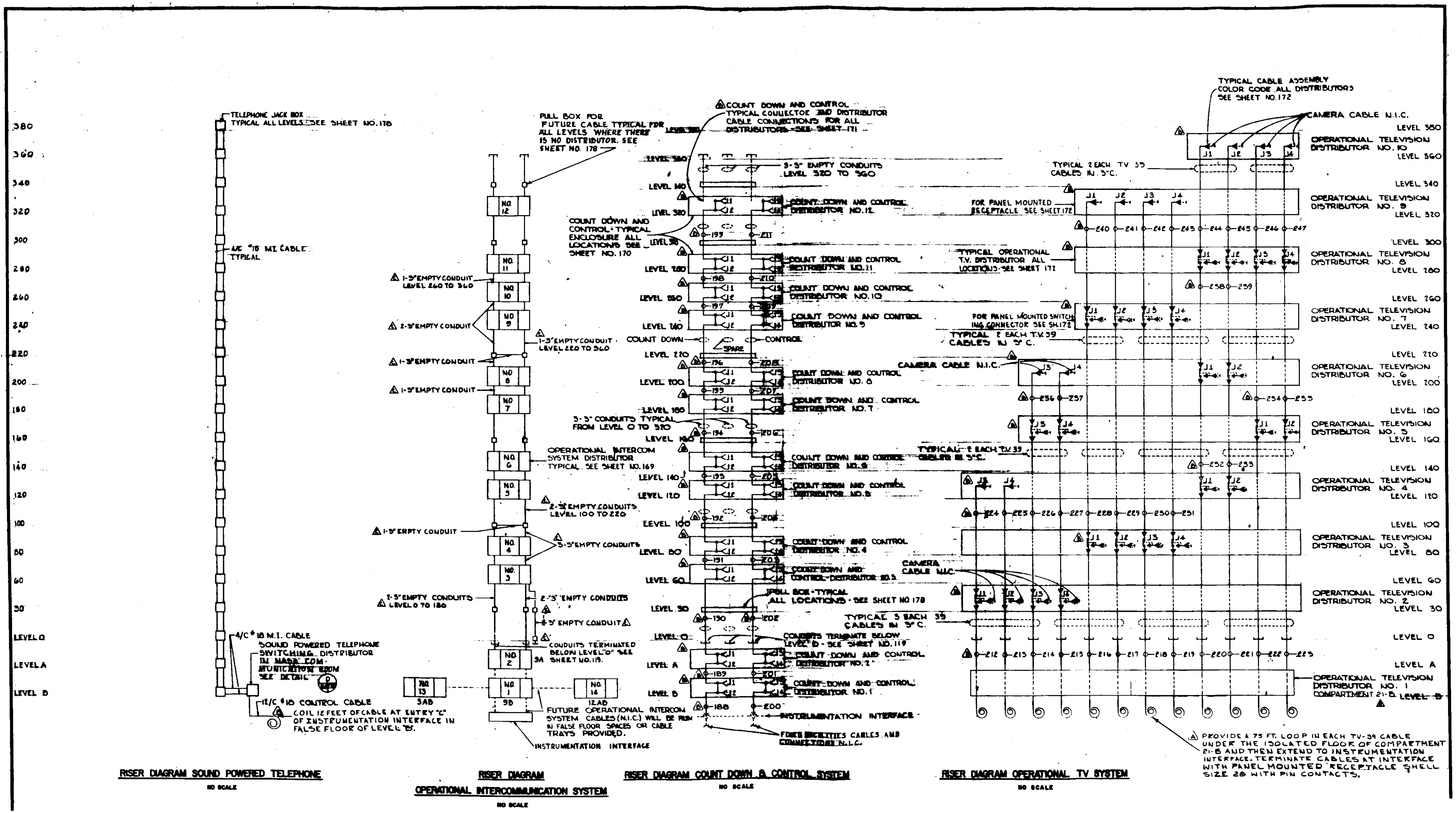


Figure 5-6. Riser Diagrams of the Sound Power Telephone System, Operational Intercommunication System, Countdown and Control System, and the Operational TV System

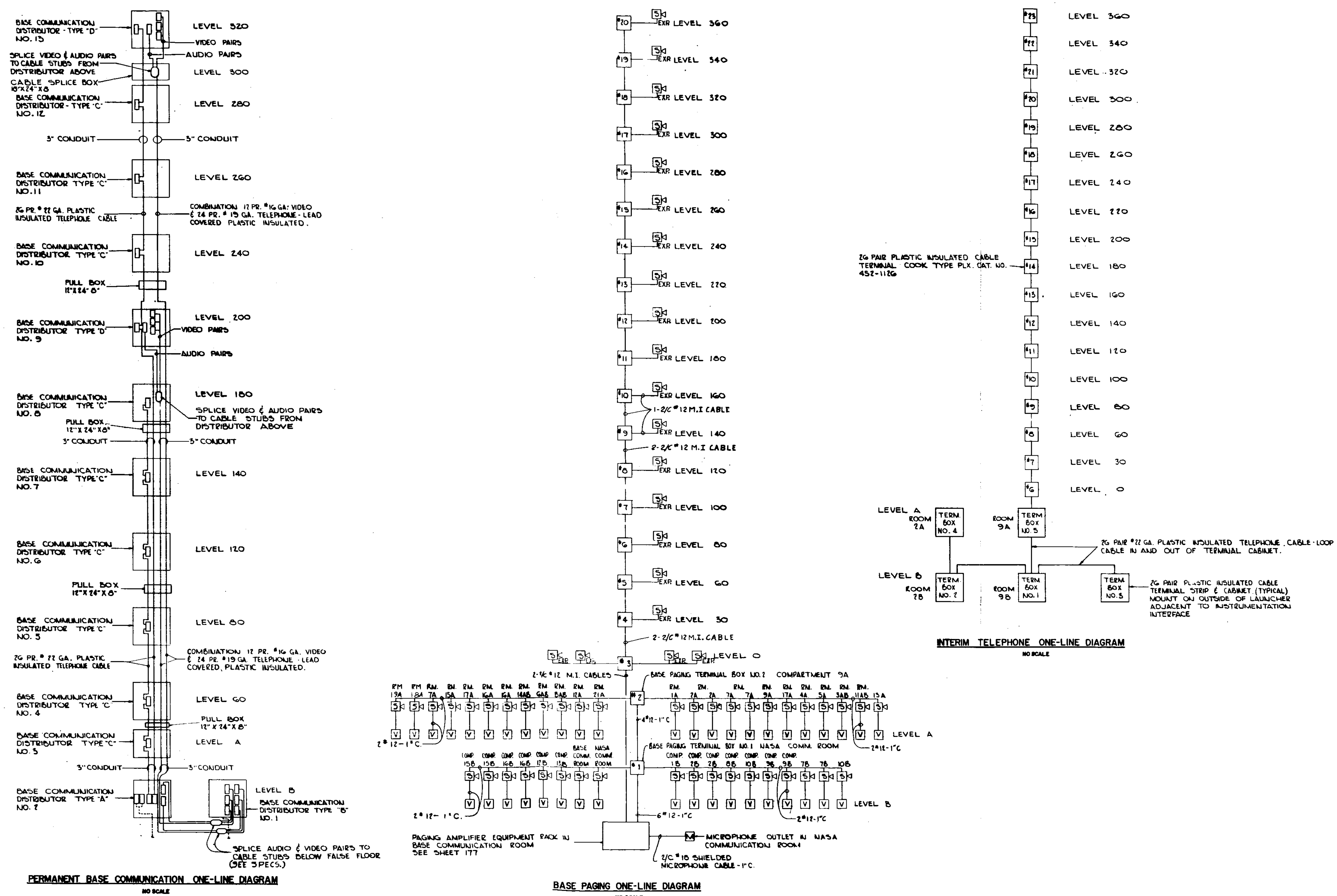


Figure 5-7. One-Line Diagrams of the Permanent Base Communication System, Base Paging System, and Intercom Telephone System

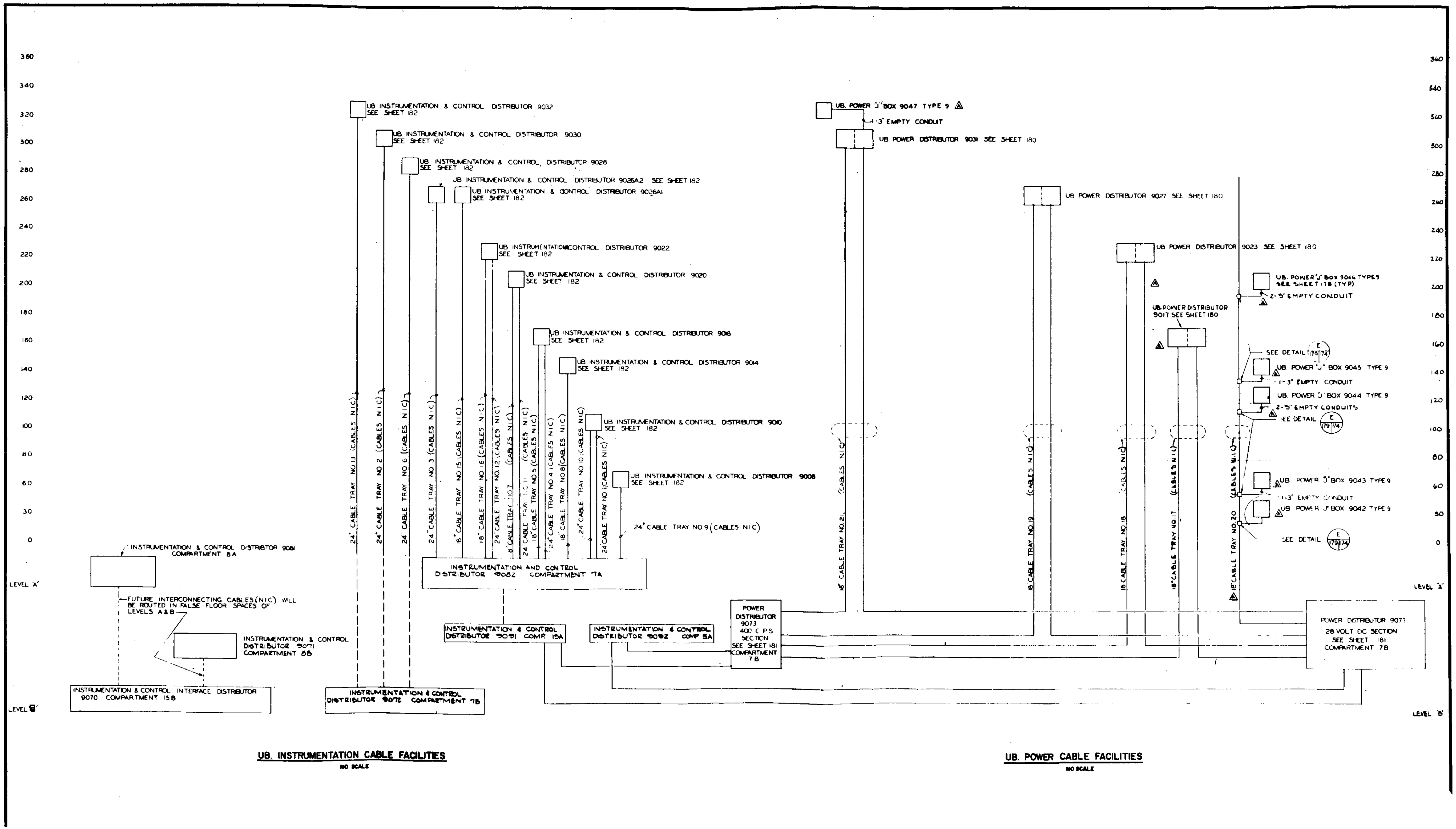


Figure 5-8. Stage-Oriented Cable Facilities One Line Diagram

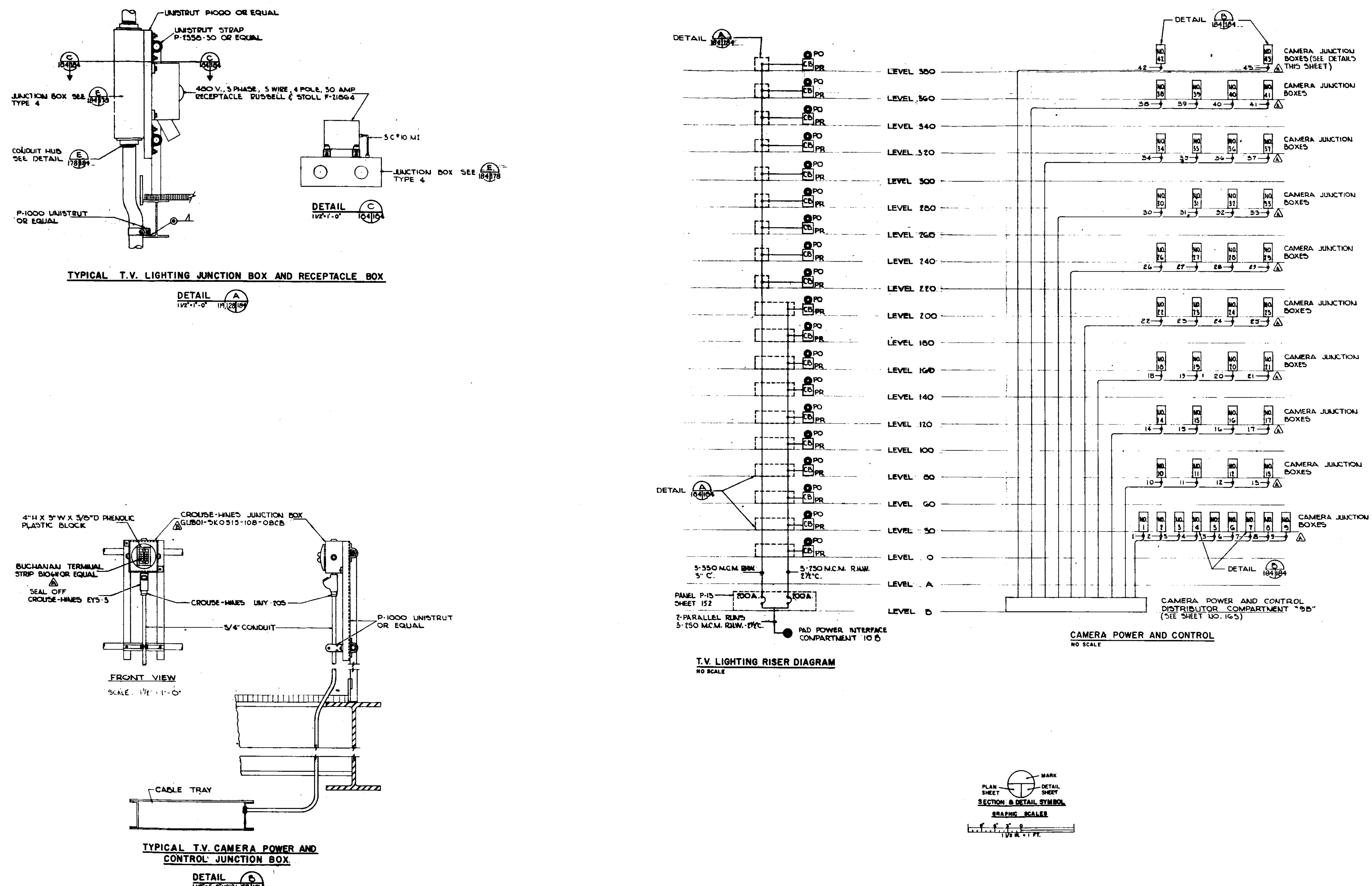


Figure 5-9. TV Lighting and Camera Power and Control System Riser Diagrams

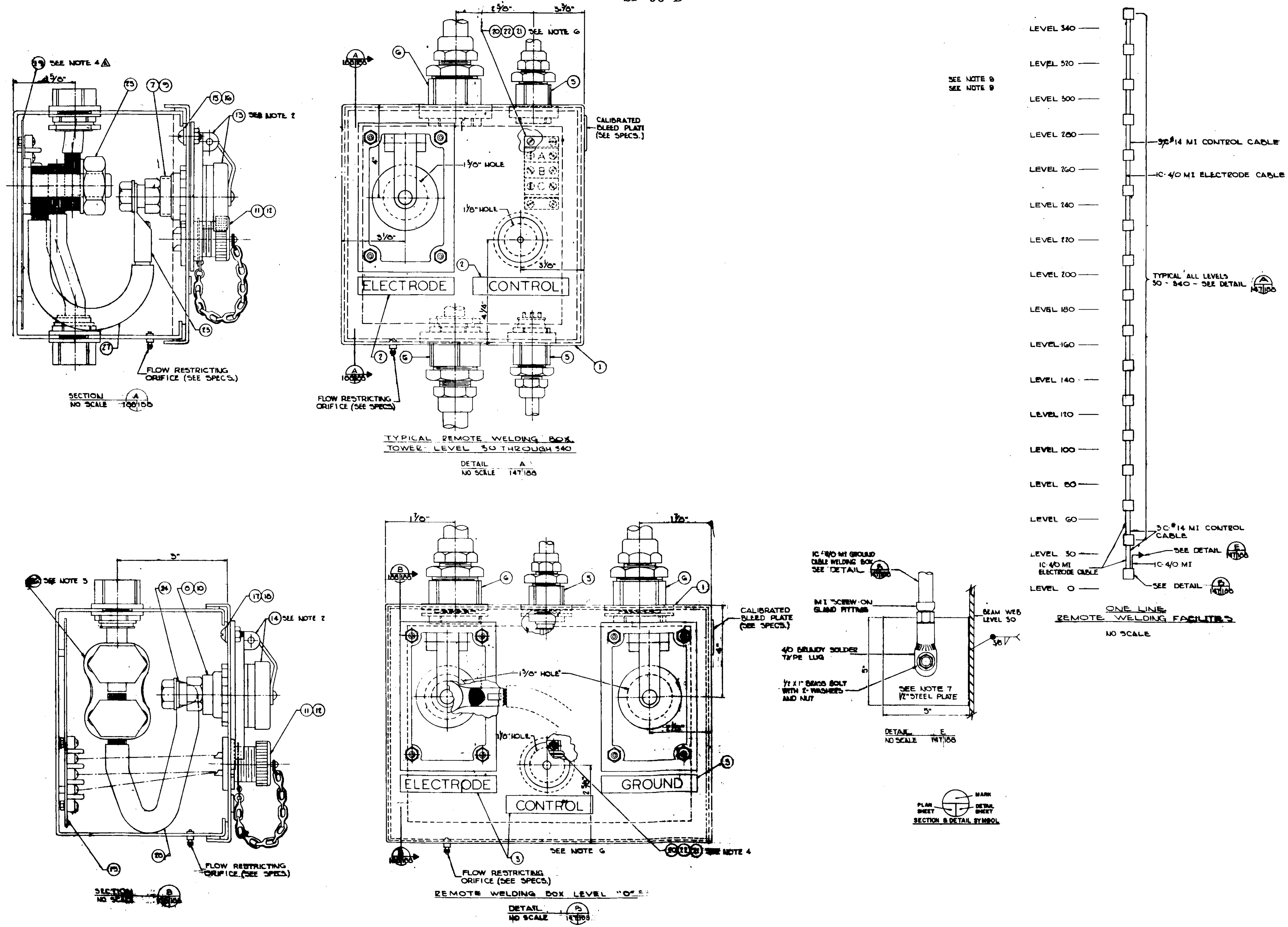


Figure 5-10. Umbilical Tower Remote Welding Facilities One-Line Diagram

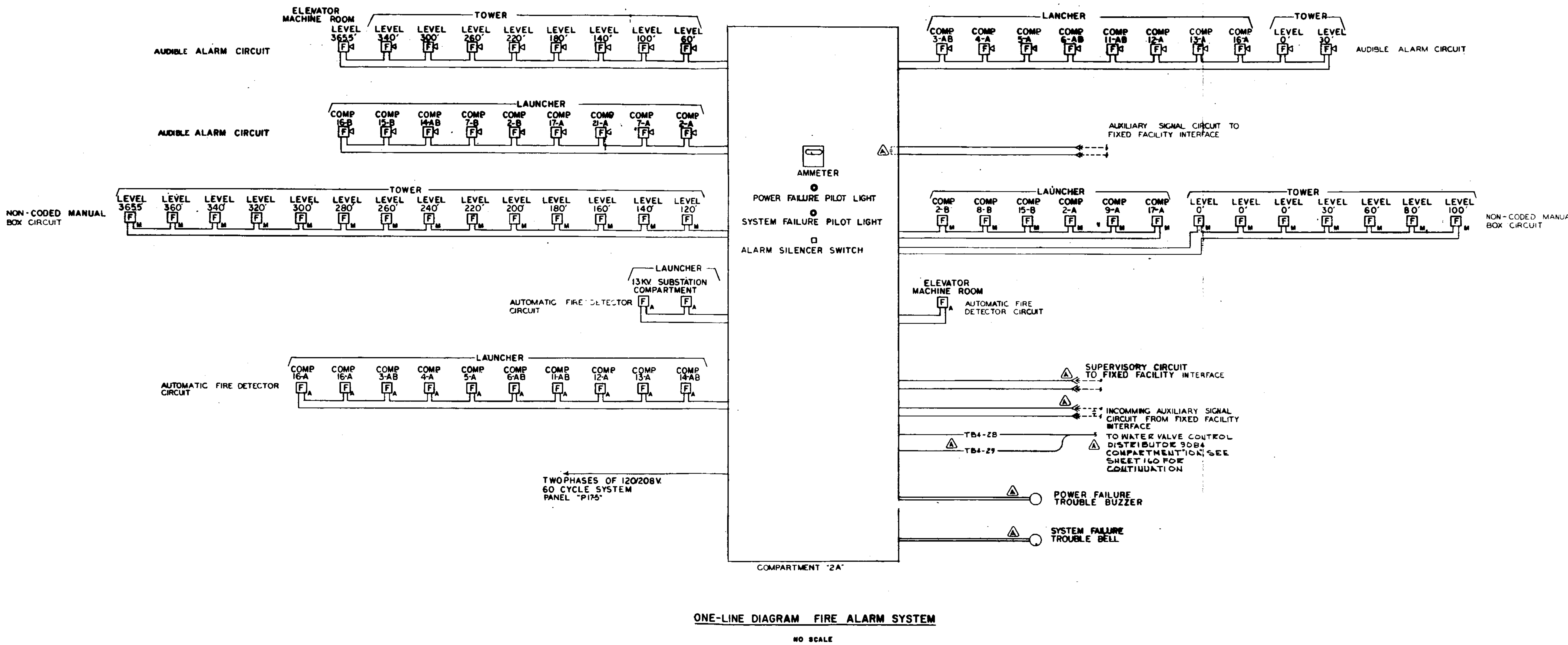


Figure 5-11. Fire Alarm System One-Line Diagram

systems onboard the LUT. The systems layout is given in figure 5-12. The control and monitoring panel shown in figure 5-13 is located in the LCC. It interfaces with the launch accessories relay rack in the LUT via the DDAS computer-hardwire complex. This relay rack provides the logic for the control and monitoring functions and also serves as an interface transfer unit. Terminal and control distributors connect the launcher accessories relay rack to valve panels and valves in the following locations:

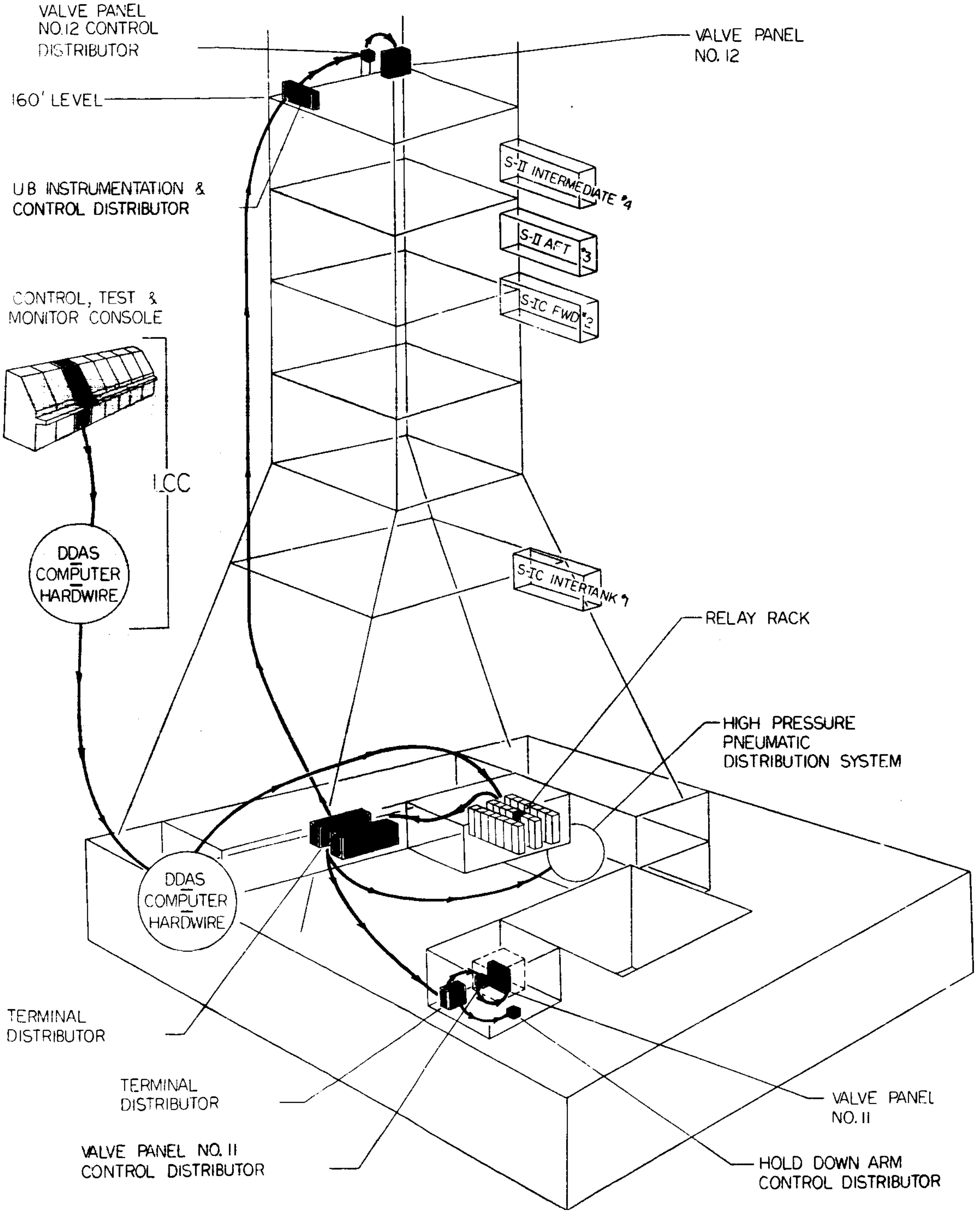


Figure 5-12. Pneumatic Control Systems Layout

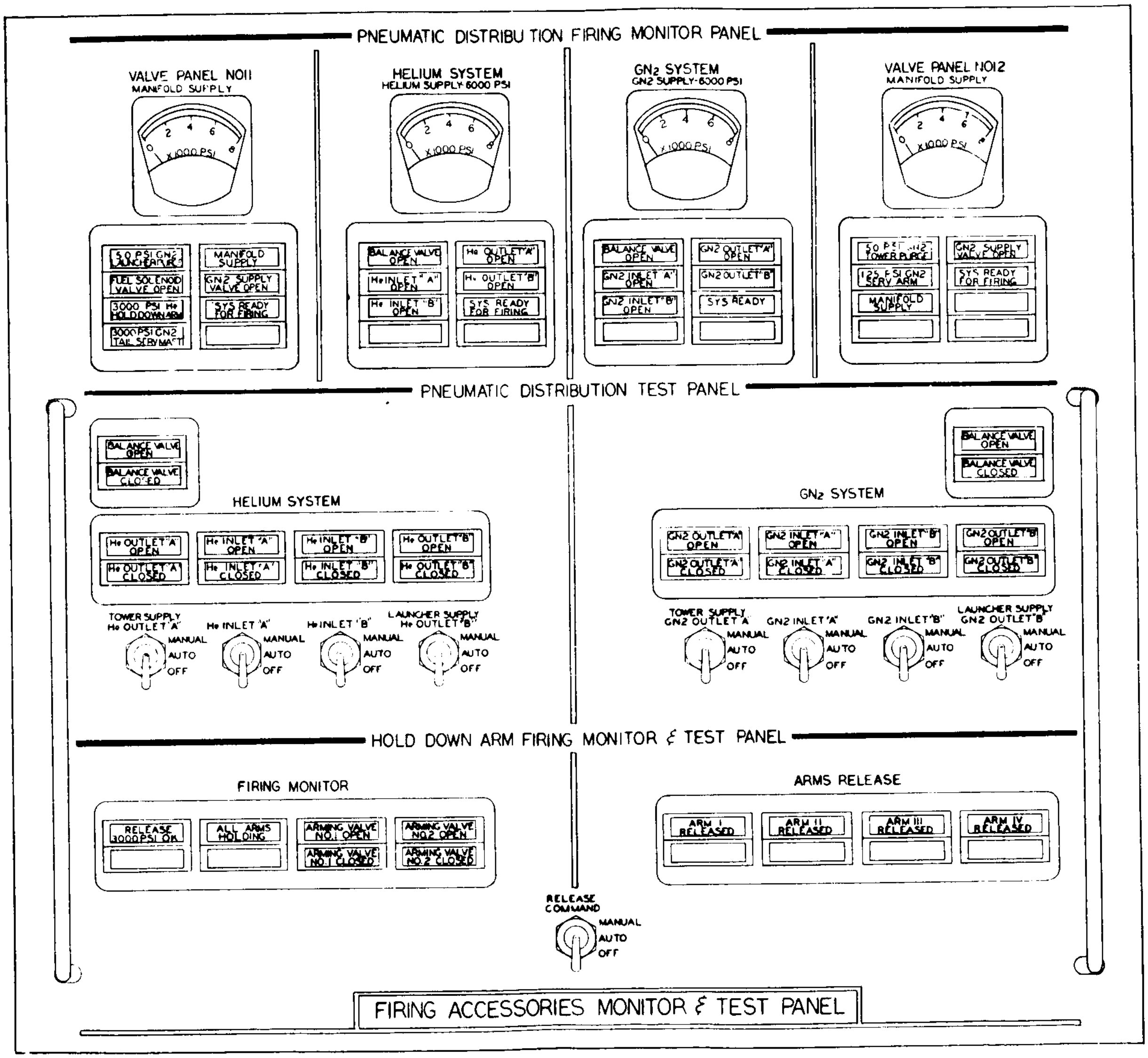


Figure 5-13. Pneumatic Control and Monitoring Panel

a. High Pressure Pneumatic Center in compartment B-1. This center contains the pneumatic manifolds and valving systems for distribution of GN_2 and Helium to valve panel 11 and valve panel 12.

b. Valve panel 12 located on tower level "160" provides the following:
1. 750 psi and 125 psi GN_2 for all service arm control pneumatics.
2. 50 psi GN_2 for hazardous conditions purge.

c. Valve Panel "11" located in compartment 13A provides the following:
1. 3000 psi and 750 psi GN_2 for TSM, ground support and hydraulic checkout.
2. 1000 psi GN_2 for engine servicing and cleaning.
3. 1500 psi helium for the holddown pneumatics.
4. 50 psi GN_2 for hazardous conditions purge requirements.

A holddown arms test set is provided to test electrical control for the holddown arms pneumatics.

5-5. UMBILICAL SERVICE ARMS CONTROL SYSTEMS

5-6. Preflight Umbilical Service Arms. Preflight electrical control and visual displays are provided by the Control, Test, and Monitor Console located in the LCC. A typical panel is given in figure 5-14. The LCC console interfaces with eleven relay racks located in the LUT, via the DDAS-Computer-Hardwire Complex. The system layout is given in figure 5-15. The relays in the LUT provide the control logic and operate as transfer units for systems operations.

Manual operation of switches on the LCC Control Console provide command signals which cause a sequence of relays in the LUT relay racks to actuate. The relay operation, in turn, applies 28 volts D-C via the terminal and control distributors, to the solenoid valves, limit and pressure switches and analog transducers associated with each tower level containing a preflight arm. The components are shown for a typical preflight arm in figure 5-16.

Actuation of the solenoid valves at the service arm locations generate feedback signals (from either switch or transducer operation) which are returned to the relay racks along a path parallel to the command signal. The feedback signals actuate relays in the LUT equipment which activate the visual displays at the LCC Control Test and Monitor Console. Simultaneously, some of these feedback signals provide stimuli for automatic-sequenced operation of the service arm.

The Portable Arm Control Console is used to test and operate a service arm from the tower. The control panels are illustrated in figures 5-17 and

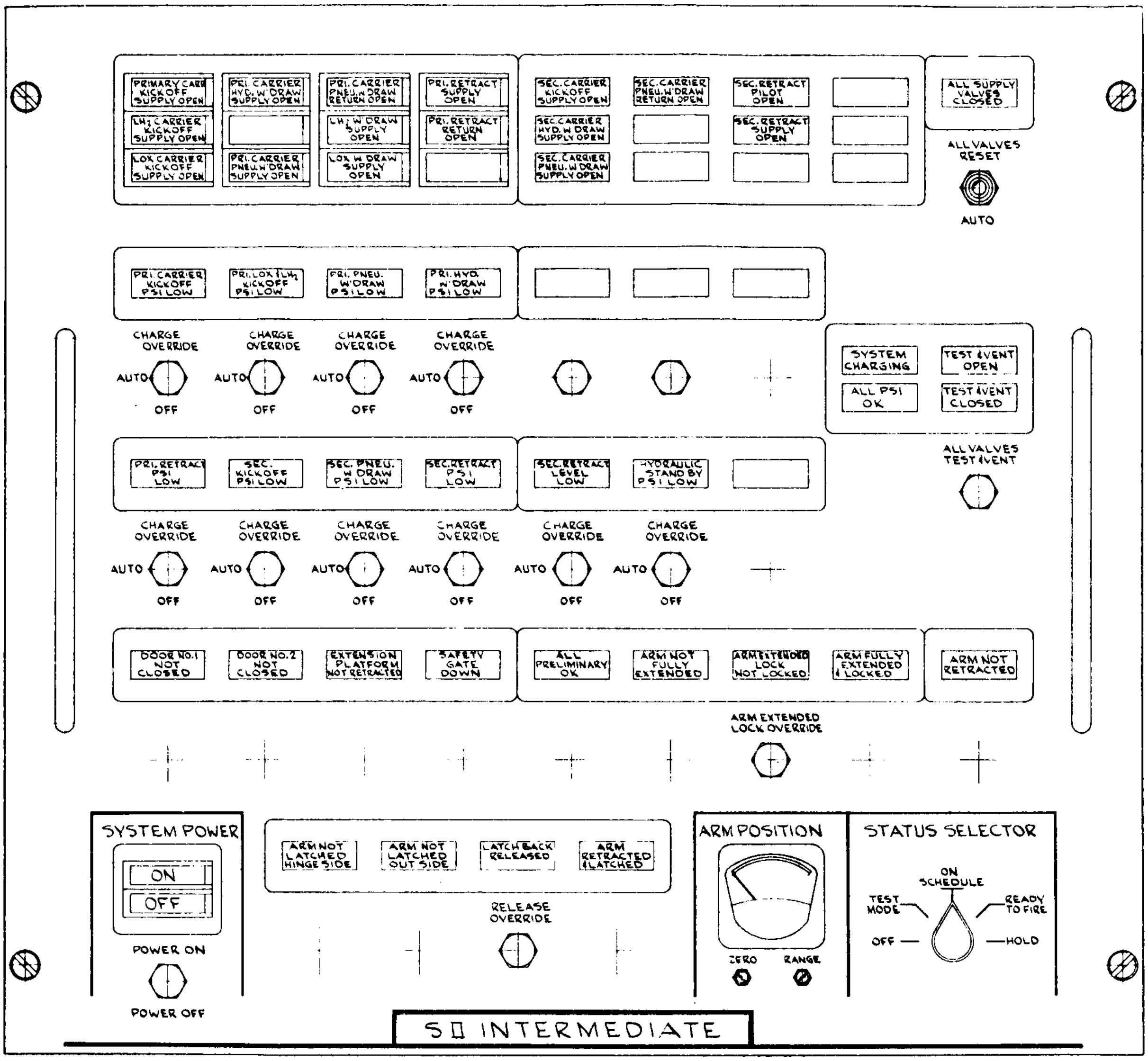


Figure 5-14. Typical LCC Control, Test, and Monitor Panel for Preflight Umbilical Service Arms

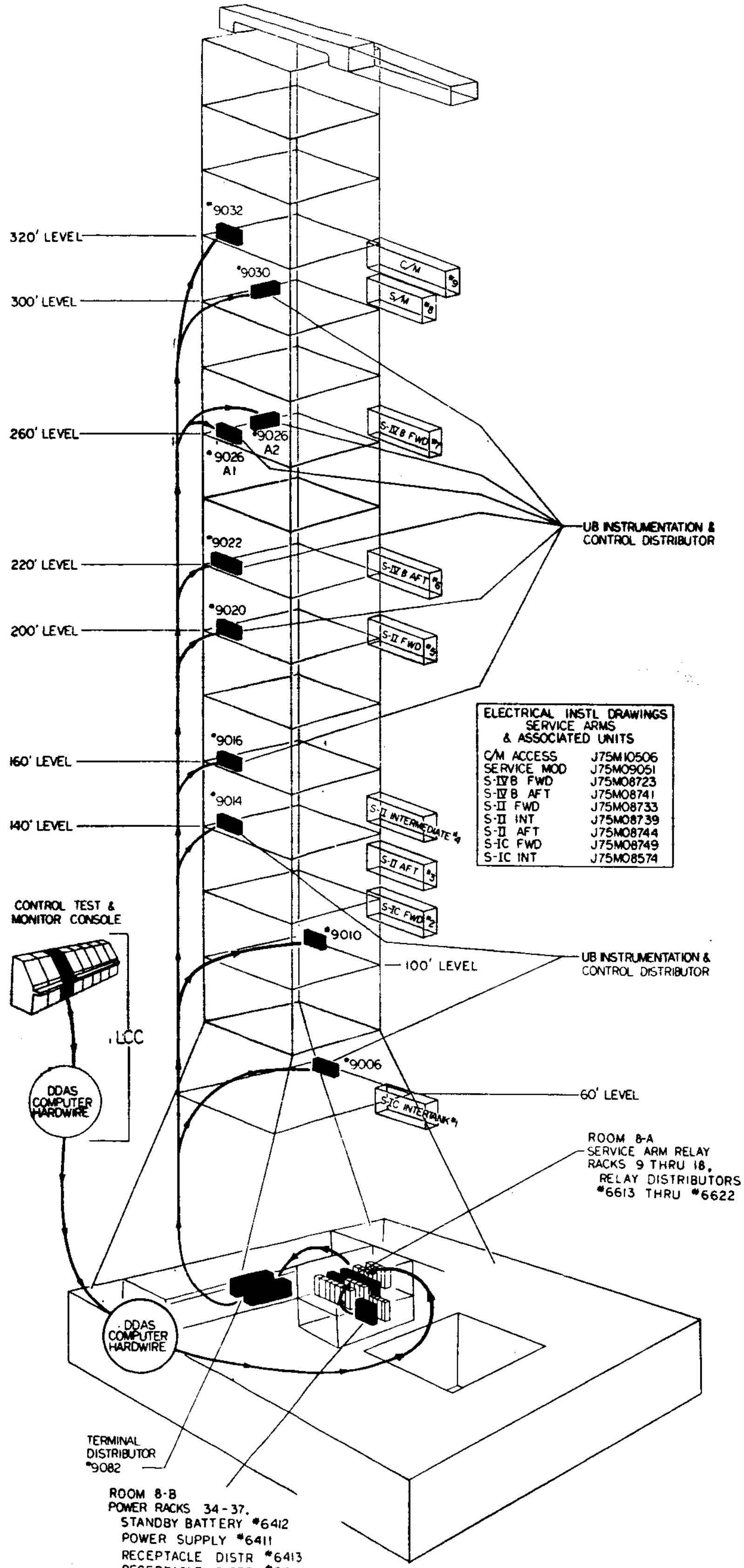


Figure 5-15. Preflight Umbilical Service Arms Systems Layout

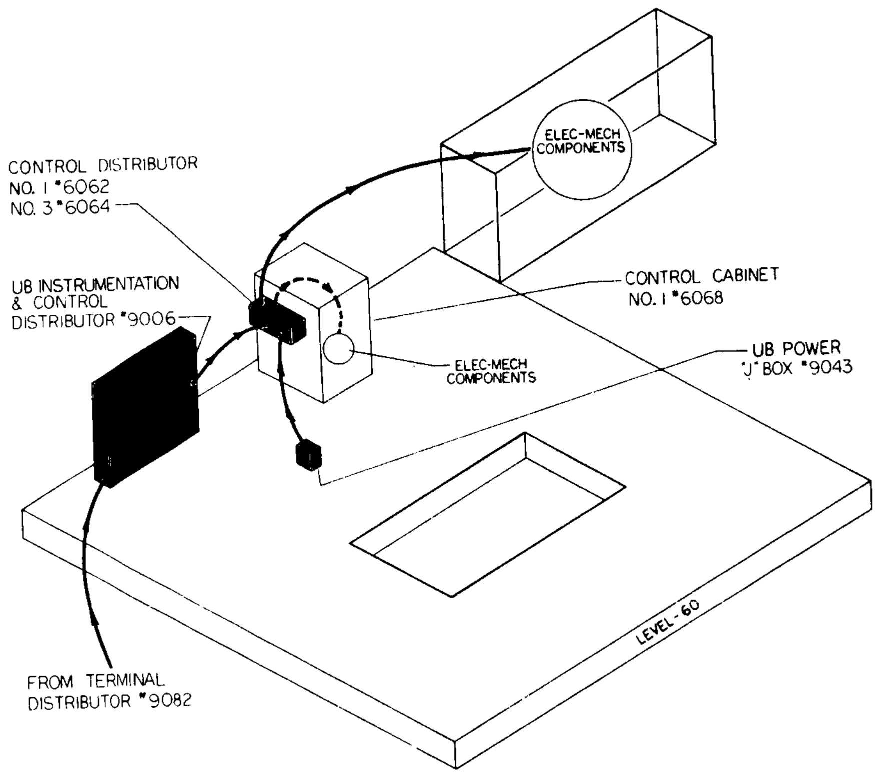


Figure 5-16. Components for Typical Preflight Service Arm

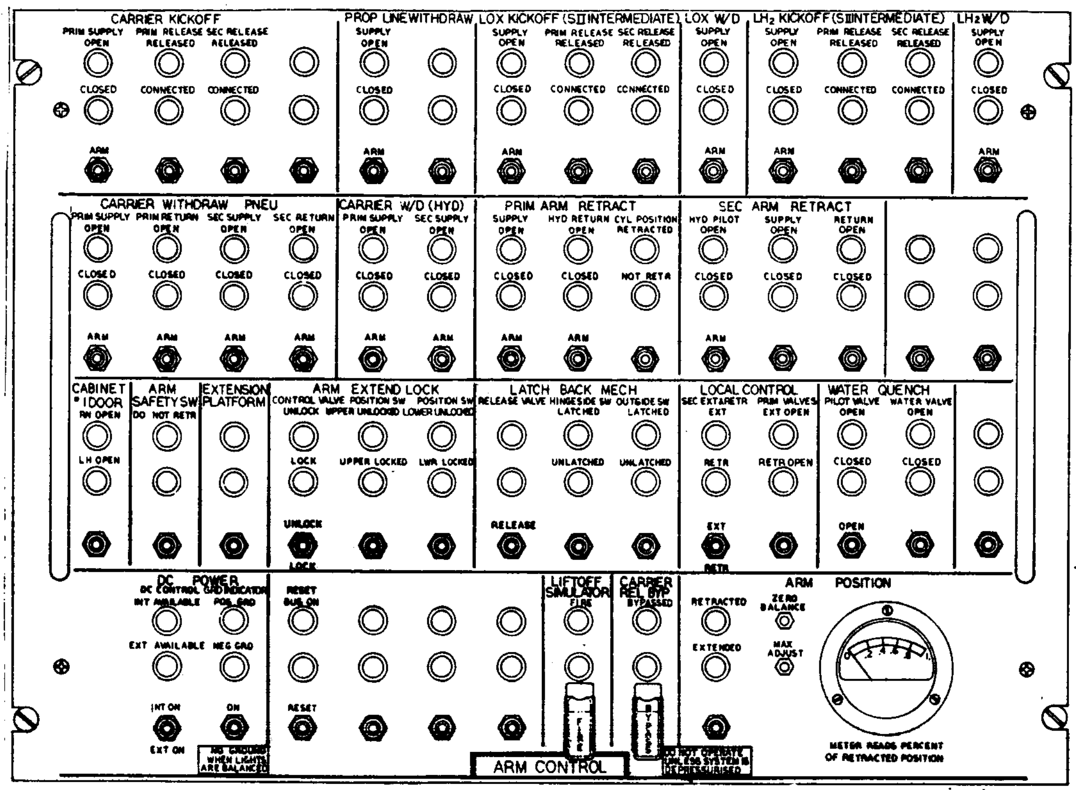


Figure 5-17. Portable Arm Control Console Panels

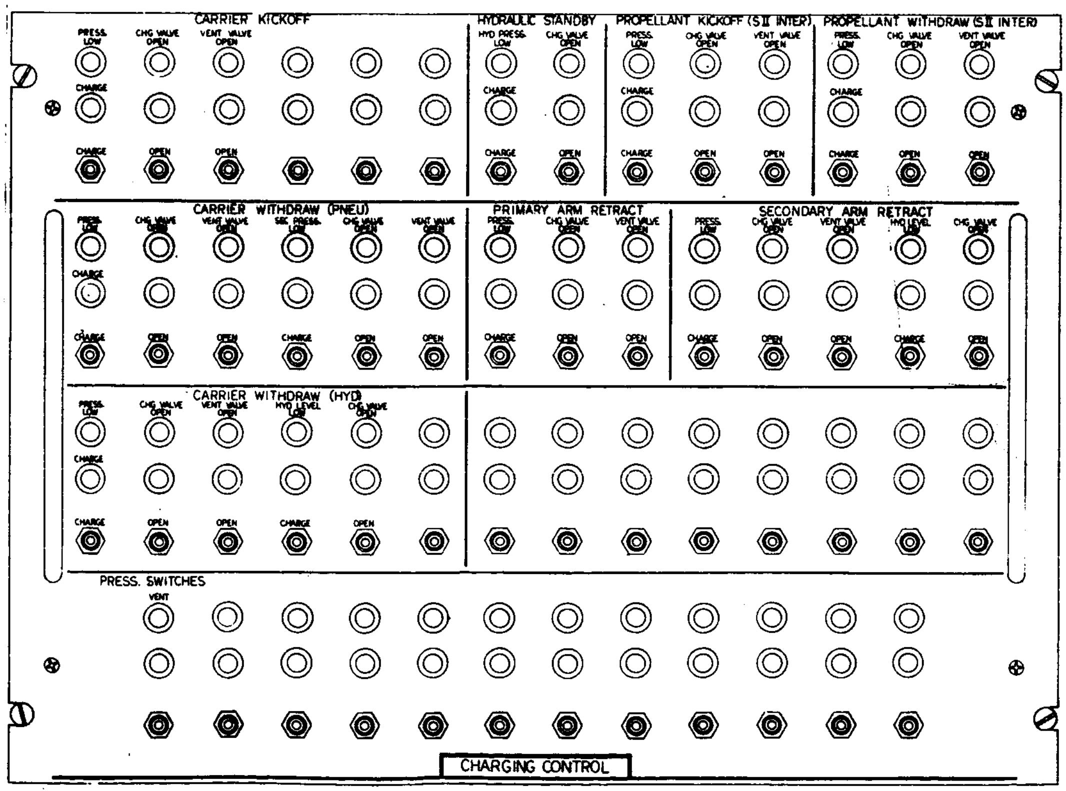


Figure 5-18. Portable Arm Control Console Panels

5-18. This console is positioned at the tower level at which the service arm is located and special test cables are connected at appropriate distributors and system components in place of the regular system cables. The Portable Arm Control Console enables the electrically controlled hydraulic and pneumatic systems to be charged and the condition of all pressure systems to be monitored. Upon completion of the charging sequence, the service arm can be operated as a complete system, or any of the three sequential steps can be performed individually. Provisions are made in the Portable Arm Control Console to monitor the operation of each critical component. A typical installation is illustrated in figure 5-19.

5-7. <u>Inflight Service Arms and Umbilical Carrier Control Systems</u>. The control system herein described provides 28-volt D-C power and the automatic sequencing required for activation of the umbilical carrier kickoff, umbilical carrier withdrawal, and service arm retraction for the five inflight service arms, the operation of which is described as follows:

An arming command provided by the automatic launch sequence program actuates appropriate relays in the arming distributor located in the LUT. These relays arm the firing circuit by applying 28-vdc power to the liftoff switches on holddown arms 2 and 4 providing two identical switch circuits for redundance and reliability.

As the vehicle rises upon launch to 3/4 inch, the holddown arm primary switch closes, applying 28 vdc from the battery supply to the primary buses in the M1 firing distributor in the LUT which, in turn, energizes each of the M1 primary distributors on the tower. Protected latching relays are also energized upon closing of the liftoff switches, maintaining a parallel circuit around the switches to insure a complete circuit under the heat and vibration conditions during launch and liftoff.

Energizing the LUT M1 firing distribution buses supplies a signal which initiates umbilical carrier kickoff. As the umbilical carrier separates, a release switch simultaneously initiates carrier withdrawal and arm retraction Voltage for this last function is also provided through the service arm M1 firing distributors.

Proper function of the primary circuit functions cause carrier kickoff, withdrawal, and arm retraction to occur before the secondary circuit is closed. However, the secondary circuit is activated regardless of proper operation of the primary circuit.

The secondary circuit closes when the launch vehicle rises 18 inches providing secondary excitation throughout. The secondary circuit initiates

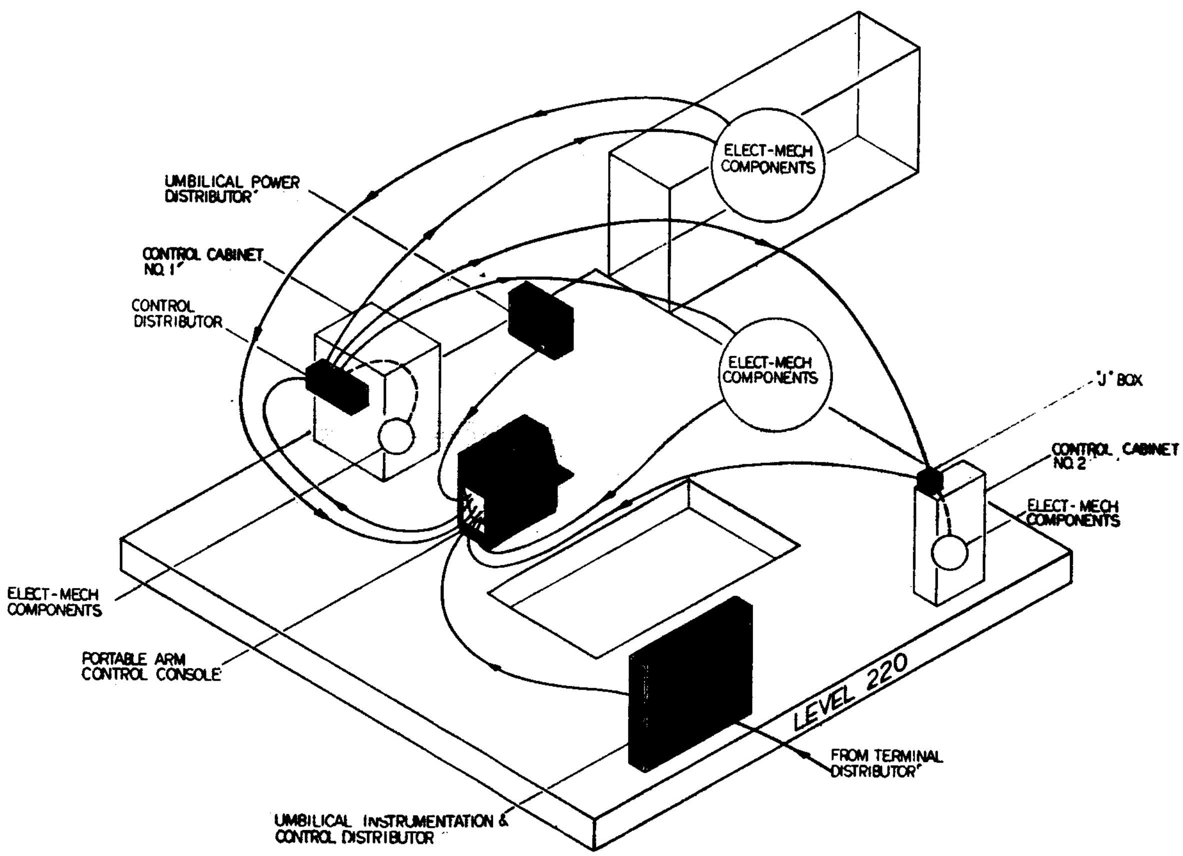


Figure 5-19. Typical Installation of Portable Arm Control Console

carrier withdrawal and arm retraction directly, since carrier kickoff will have already been affected mechanically. Altogether, two primary and two secondary circuits provide four possible means to effect actuation of the umbilical carriers and service arms at launch.

Functions of the five inflight arms which are common to the preflight service arms were covered in the preceding systems description for the preflight service arms.

5-8. TAIL SERVICE MASTS CONTROL SYSTEM

The LCC Control, Test, and Monitor Panel (figure 5-20) provides visual displays of the critical system parameters and control of the hydraulic and pneumatic charging, pressurization test, and the retract tests. The console interfaces with two relay racks located in the LUT via the DDAS-computer-hardwire complex as shown in figure 5-21. The relay rack provides control logic and also functions as a transfer unit for the TSM subsystem which, overall, operates as follows:

Automatic control signals from the computer (or signals from the LCC console, if manual override is required) actuate relays in the relay rack. Relay operation in turn, applies 28-vdc via terminal and control distributors to analog transducers, limit and pressure switches, and solenoid valves within each TSM, as shown in figure 5-22. Mechanical movements of the tail service masts and their control mechanisms are monitored by switches and transducers which return feedback signals to the relay racks along a return path parallel to the command signals. In the relay racks, the feedback signals provide stimuli for the continuance of test during automatic operation. During the launch, the stimulus which initiates tail service mast retraction is vehicle motion.

For mast extend locate control and test of each tail service mast, a portable TSM test set shown in figure 5-23 is employed. Two cables from this test set replace cables from the base of the TSM Control Distributor. Power is supplied to the test set by a portable 28-vdc supply. When the TSM test set is used, each electrical component within the tail service mast may be controlled and monitored.

5-9. HYDRAULIC CHARGING UNIT CONTROL SYSTEM

The Hydraulic Charging Unit, illustrated in figure 5-24, consists of two identical but separately controlled pumping units. Each unit employs a 20-hp, 440-volt A-C motor-pump combination. Both motor pump units are connected to a common hydraulic reservoir.

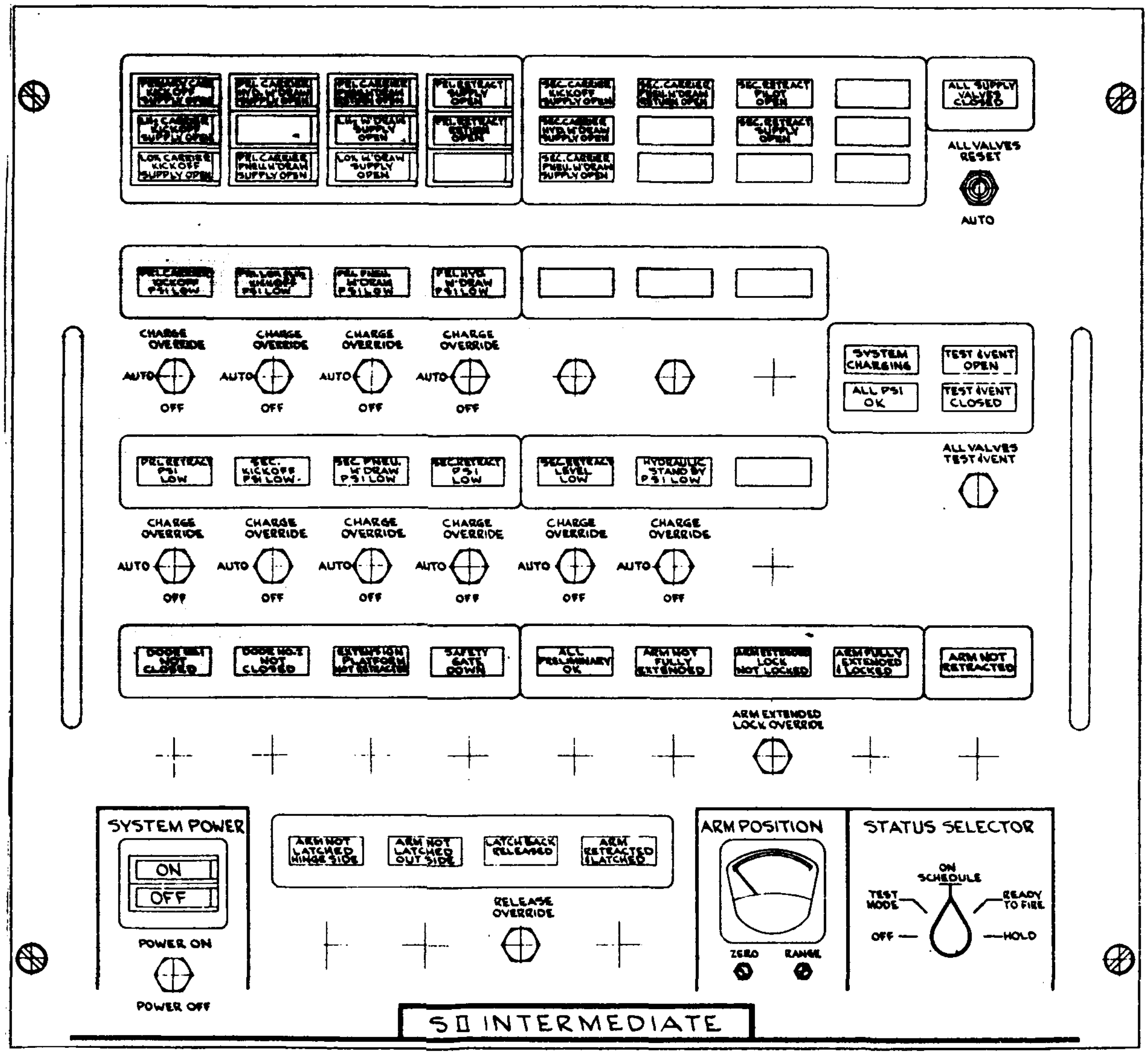


Fig. 5-20 Service Arms System, S-II Intermediate (Typical), Summation Panel

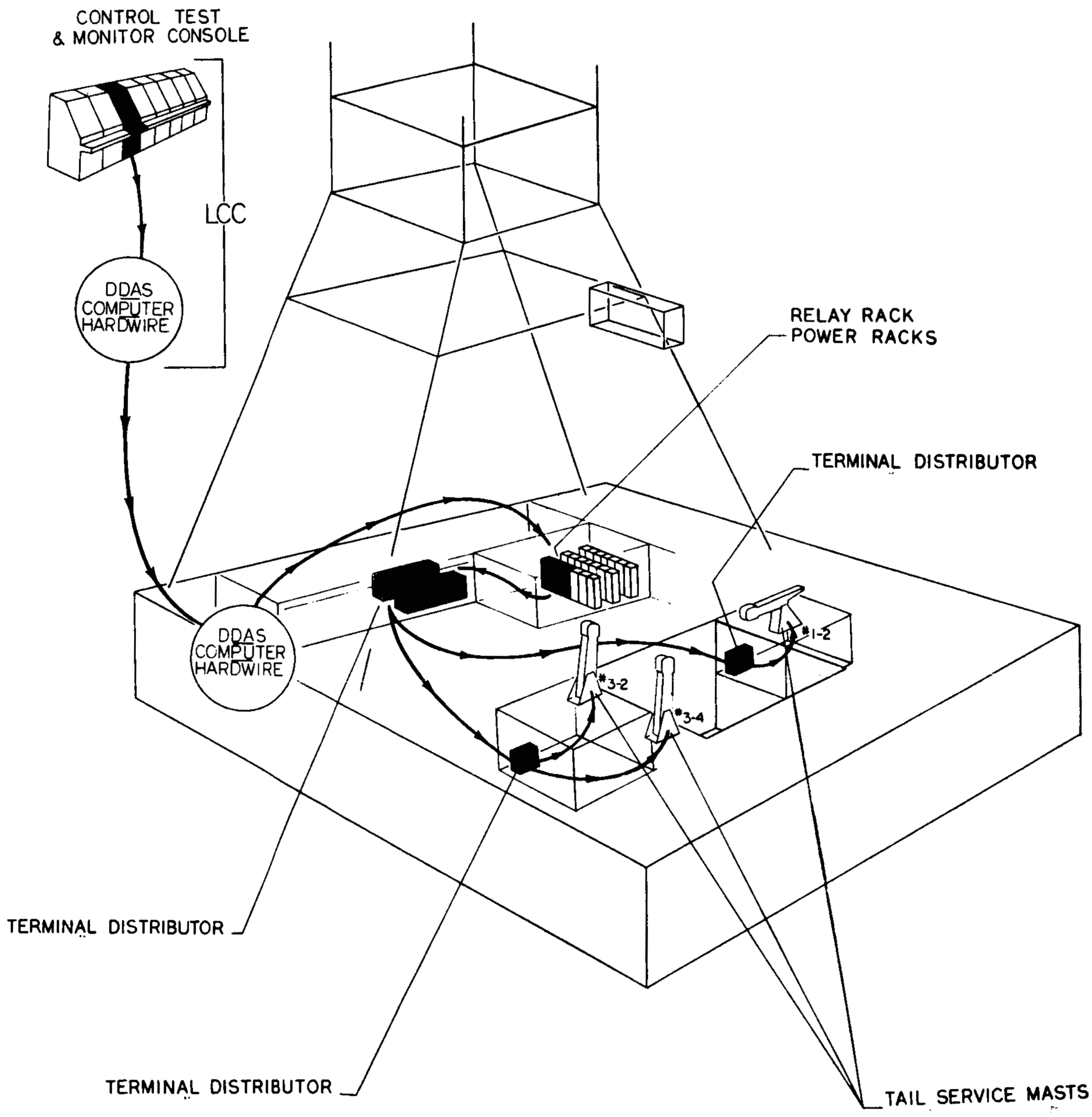


Figure 5-21. Console Interfaces for TSM Control System

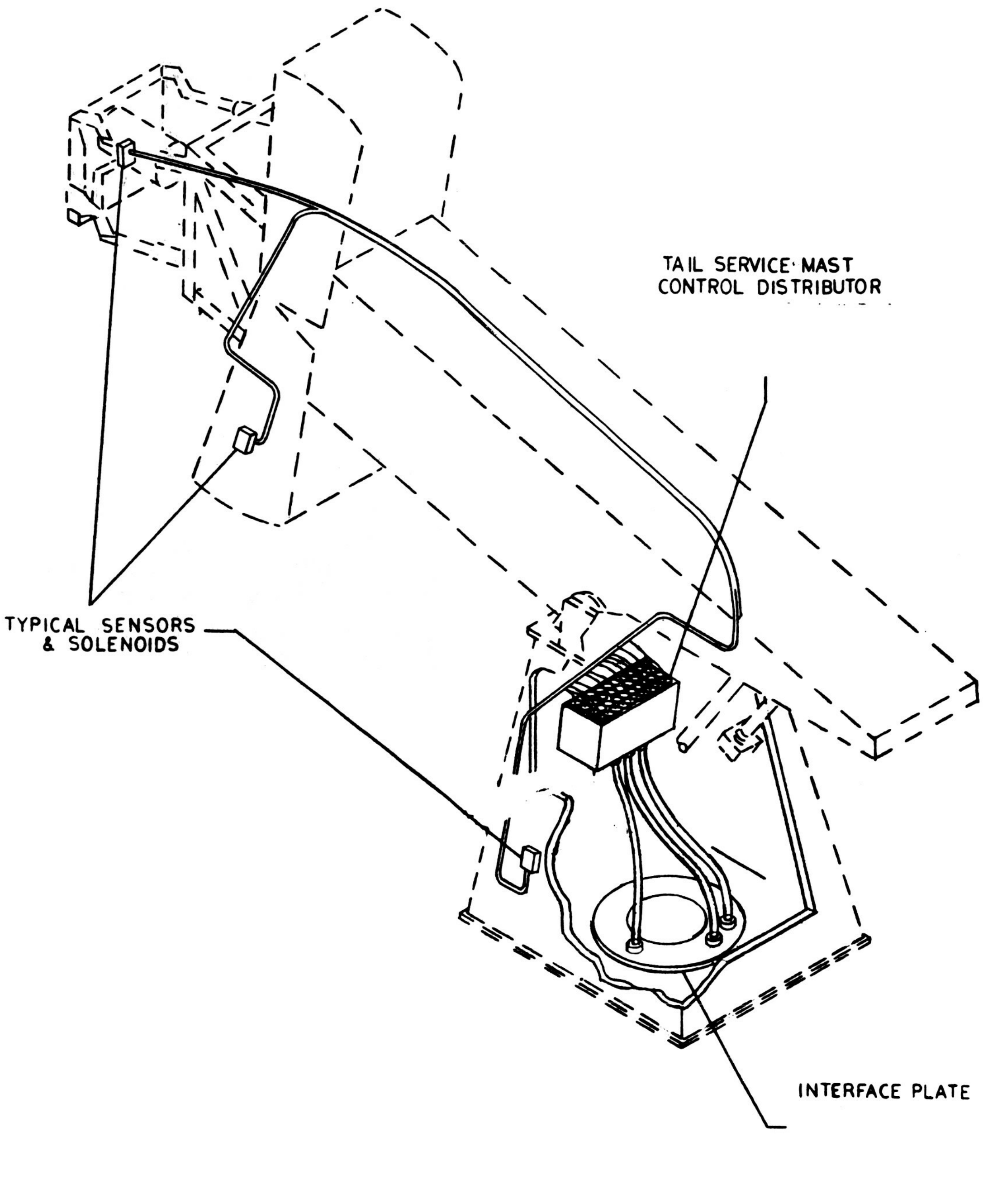


Figure 5-22. TSM System

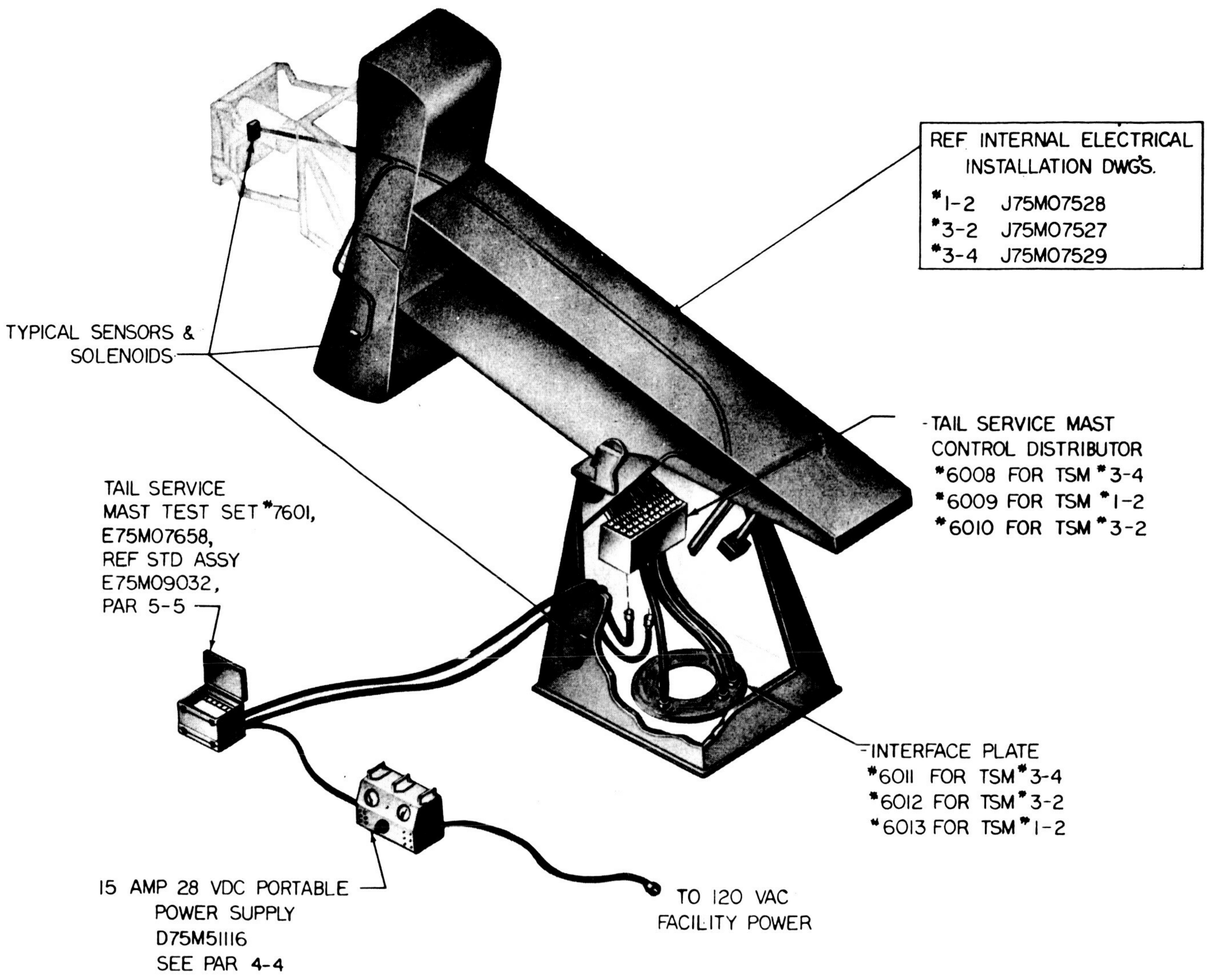


Figure 5-23. TSM Test Set

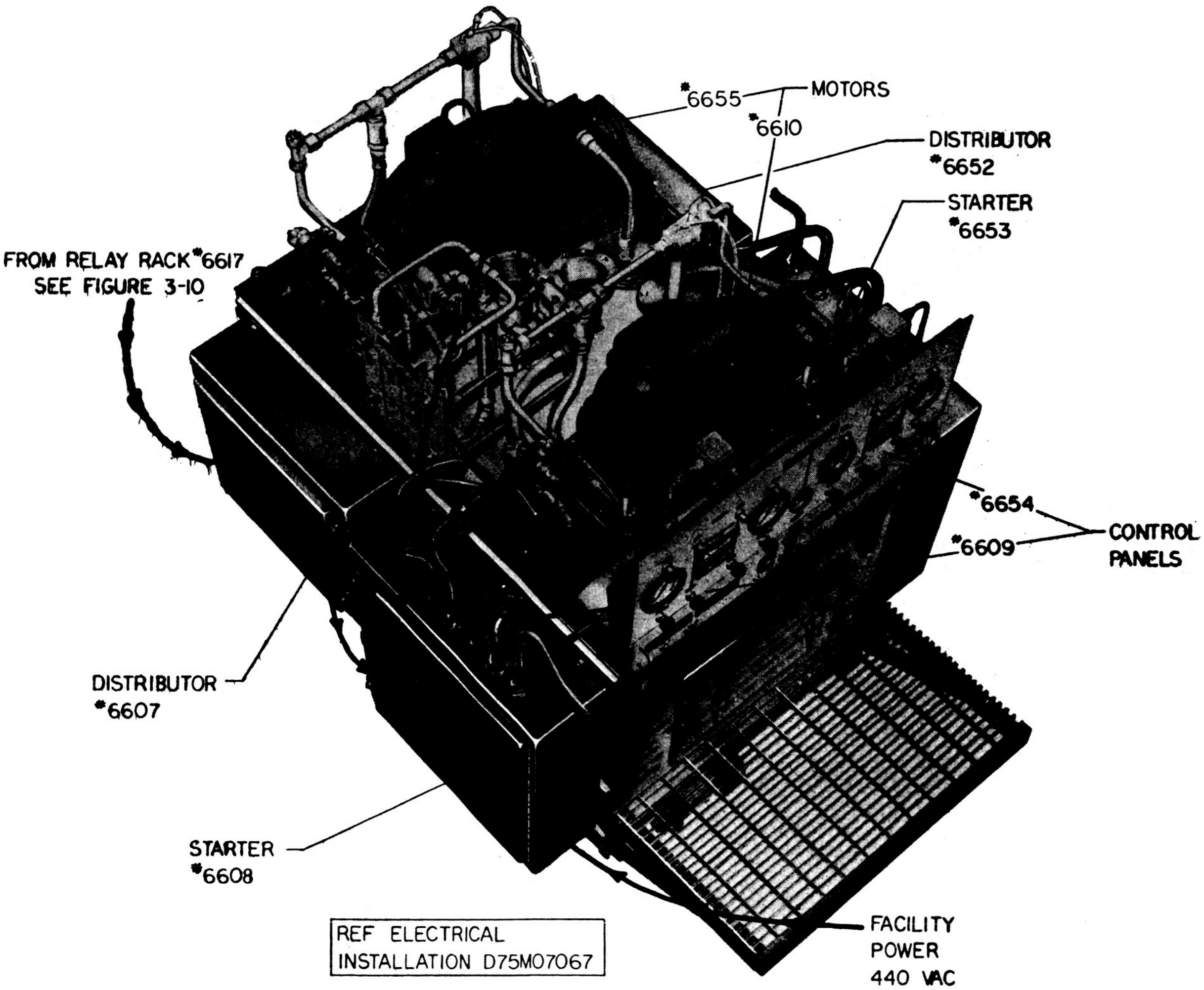


Figure 5-24. Hydraulic Charging Unit

The control system for each motor-pump unit employs a separate starter and distributor connected to a common LCC control panel and relay rack. The systems layout is given in figure 5-25.

Actuating the start switch on the LCC Control and Monitor Panel applies 440-vac to an auto transformer motor-starter. The starter energizes the motor at a reduced voltage and increases it sequentially to the rated level as full operating speed is attained. This starting method protects the motor and minimizes current surges.

Monitoring signals from the Hydraulic Charging Unit are transmitted through the charging unit distributor and relay rack back to the LCC Control Panel. These monitor signals include motor temperature, A-C power, D-C power, and hydraulic pressure.

During LUT transit, or whenever the LCC interface is broken, the control cables from the Relay Rack are removed and connections to the local control panel are substituted instead. Local control of the system allows the hydraulic charging unit to continue operation under the above conditions.

5-10. HOLDDOWN ARMS CONTROL SYSTEMS

The holddown Arm Control System has not been defined as yet. In general, the holddown release command will be given during the automatic countdown sequence at launch commit. This signal is routed to the LUT ESE via a patch distributor, to the appropriate relay racks and hence, to the holddown arm distributor which is the point of electrical interface. Power from the relay rack actuates a system of solenoid valves pressurizing the release cylinders of the holddown arms. A typical LCC Holddown Arm Firing Monitor and Test Panel is included in figure 5-13.

5-11. ENGINE SERVICING PLATFORMS CONTROL SYSTEM

The platforms given below are required at the VAB and the launch pad for servicing the Saturn S-IC stage and function as accessories to the LUT.

a. The LUT Level Servicing Platform illustrated in figure 5-26 is a passive platform which provides servicing access to the S-IC stage at deck level "0." It is carried as an accessory to the LUT and is removed only at a short interval prior to launch. It returns to the LUT upon leaving the pad area.

b. The Pad Engine Servicing Platform illustrated in figure 5-27 services the engine area. This platform which is heavier than (a) given above, incorporates level sensors, interlocks, and other control equipment not contained in platform (a).

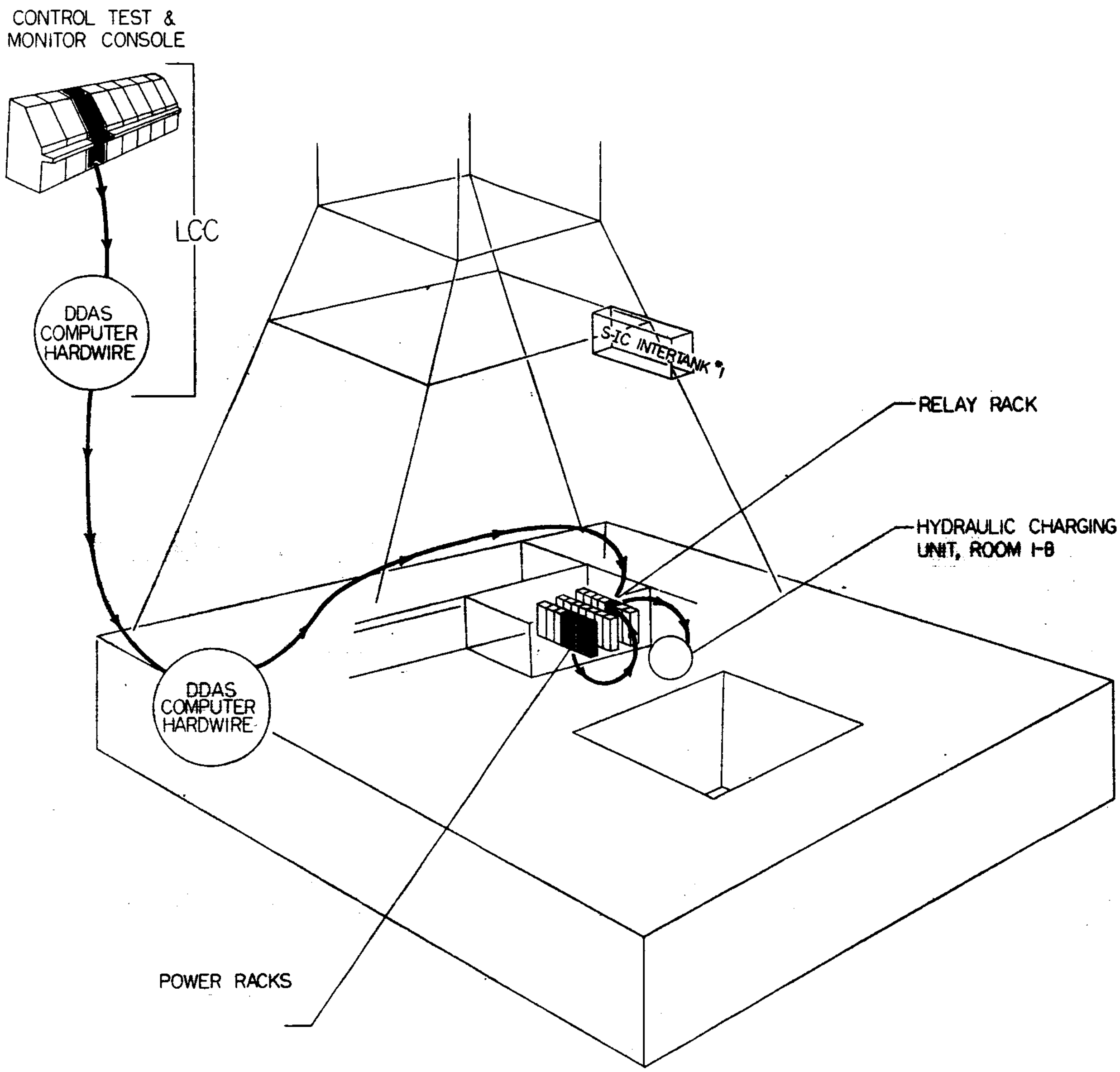


Figure 5-25. The Control System Layout for the Hydraulic Charging Unit

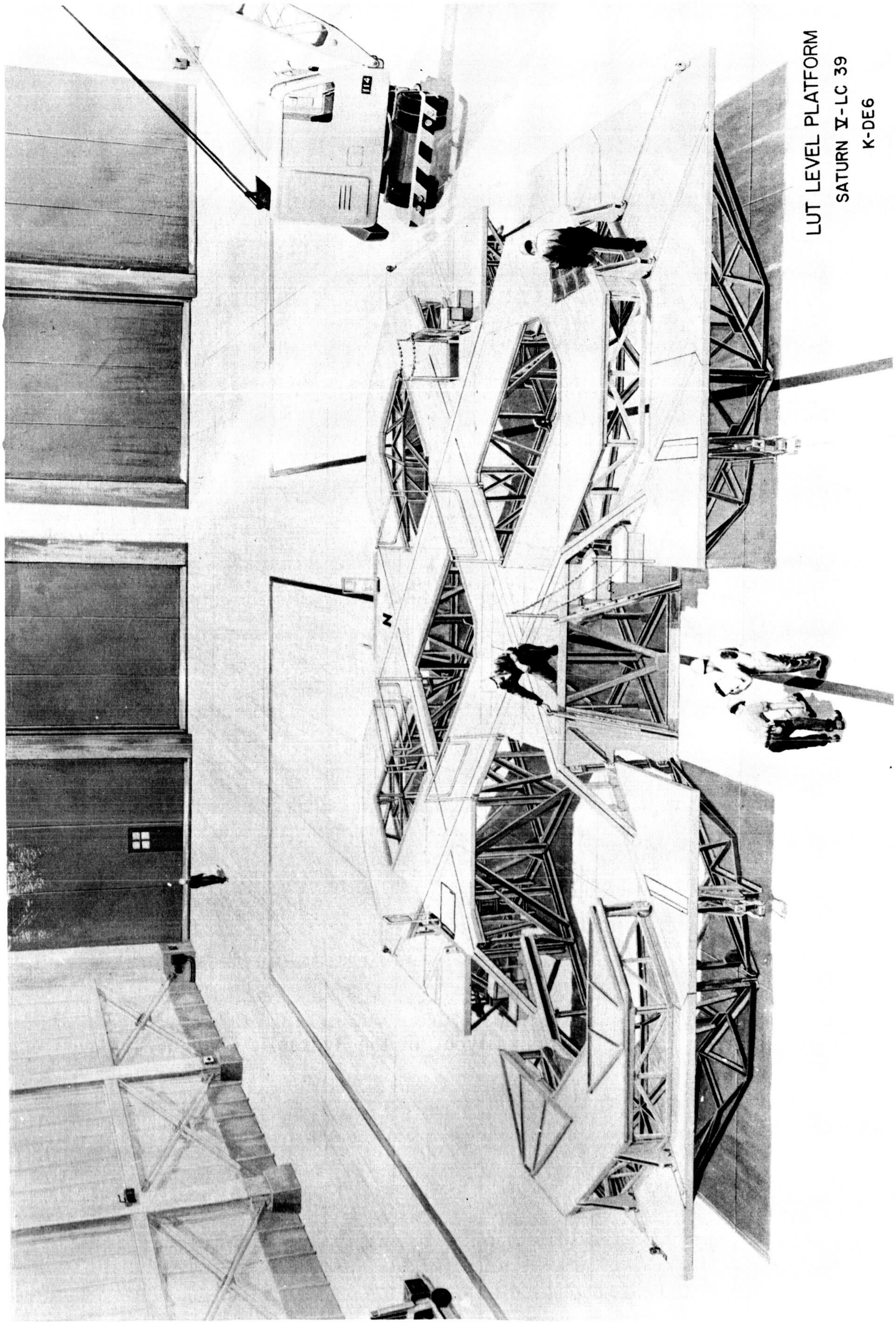


Figure 5-26. LUT Level Servicing Platform

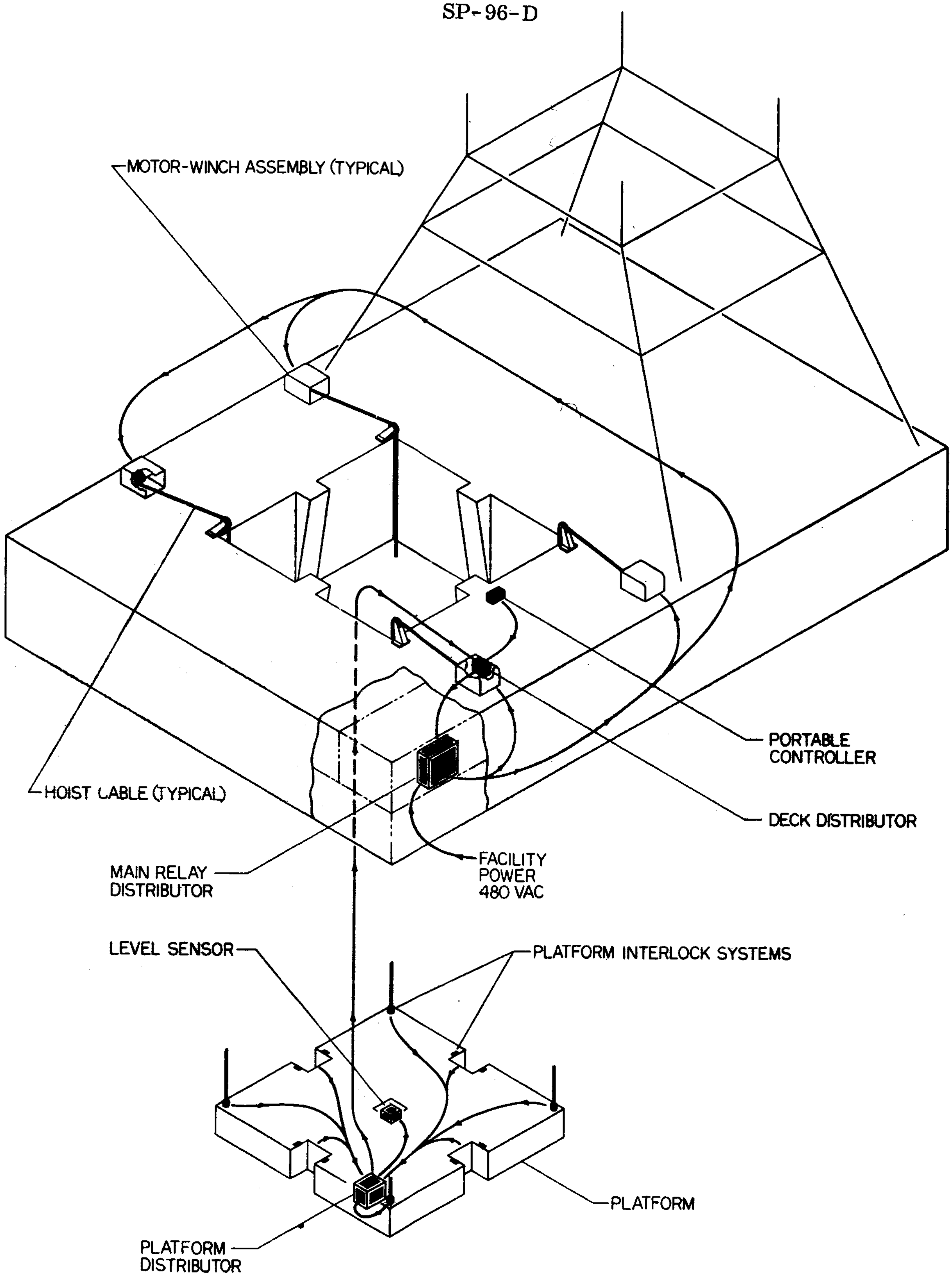


Figure 5-27. Pad Engine Servicing Platform

c. The VAB Engine Servicing Platform is heavier than (a) or (b), and is utilized to service the engine area, install engine skirts, and also is capable of accommodating a change of an F-1 engine. This platform contains the same control equipment as platform (b). An illustration of the platform is given in figure 5-28.

The three platforms, represented in a single generalized form in figure 5-29 are raised and lowered by a cable hoist mechanism which is locally controlled by an operator on the LUT deck.

The electrical control system normally employs four motor winch assemblies, operating simultaneously. It is capable of lifting a balanced platform load such as the center or inboard F-1 engine. Step control is achieved with two speed motors.

Electrical power is also provided for a fifth motor winch assembly which is removable. This assembly will provide additional hoist capacity for any platform corner to accommodate a heavy or unbalanced load, such as an outboard F-1 Engine.

Certain special equipments are used to support the motor winch assemblies. These equipments and their functions follows:

a. The Relay Distributor provides control logic and power to motors and control system. This is done by direct cabling from the distributor to the motors and control elements.

b. The Deck Distributor located inside motor winch housing "D" provides the means for connecting the portable hand controller to the system.

c. The Platform Controller illustrated in figure 5-30 winch is connected to the system via the Deck Distributor, provides "on-off" speed and direction control of the motors. The motors may be controlled individually or collectively.

d. The Platform Distributor routes interlock signals and distributes power to various platform locations.

e. The Level Sensors detect platform tilt and transmits this information to the Portable Controller via the platform and deck distributors. This information is monitored by the operator for manual corrections.

f. The overall systems incorporates a maximum height interlock and cable tension indications and interlocks. All exposed equipment is designed for

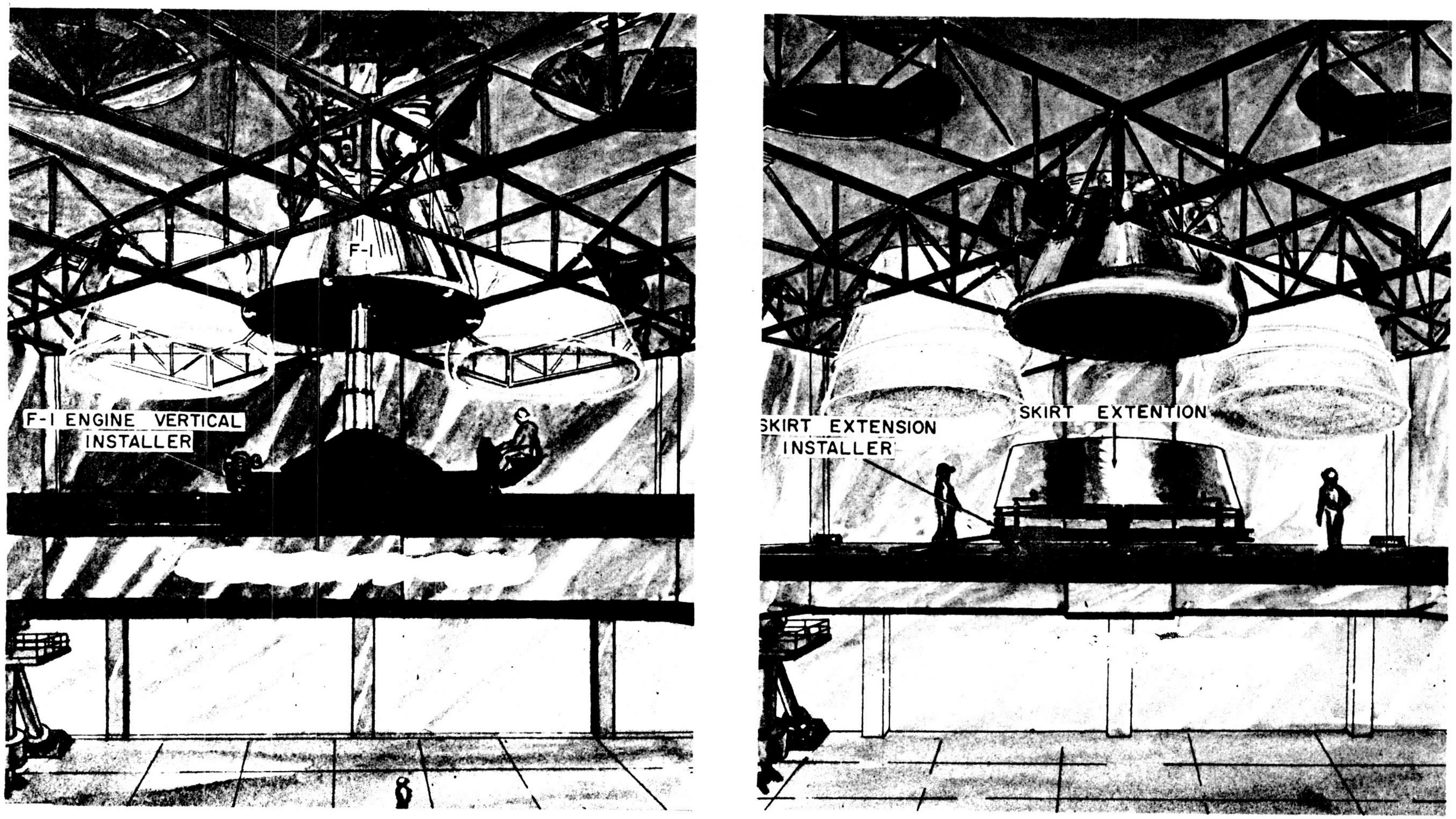


Figure 5-28. Typical Operation of the Pad Engine Servicing Platform

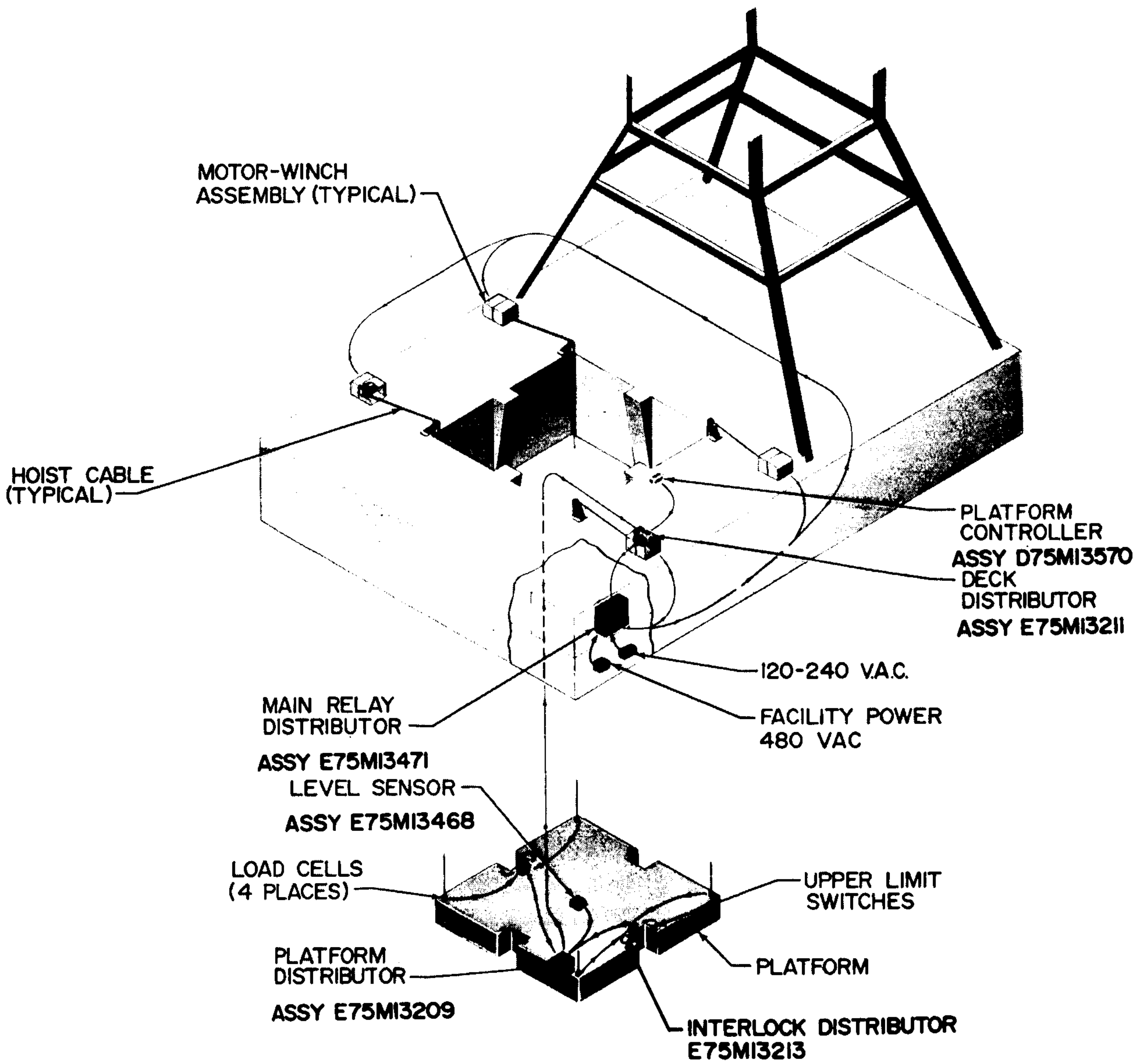


Figure 5-29. Typical Service Platform

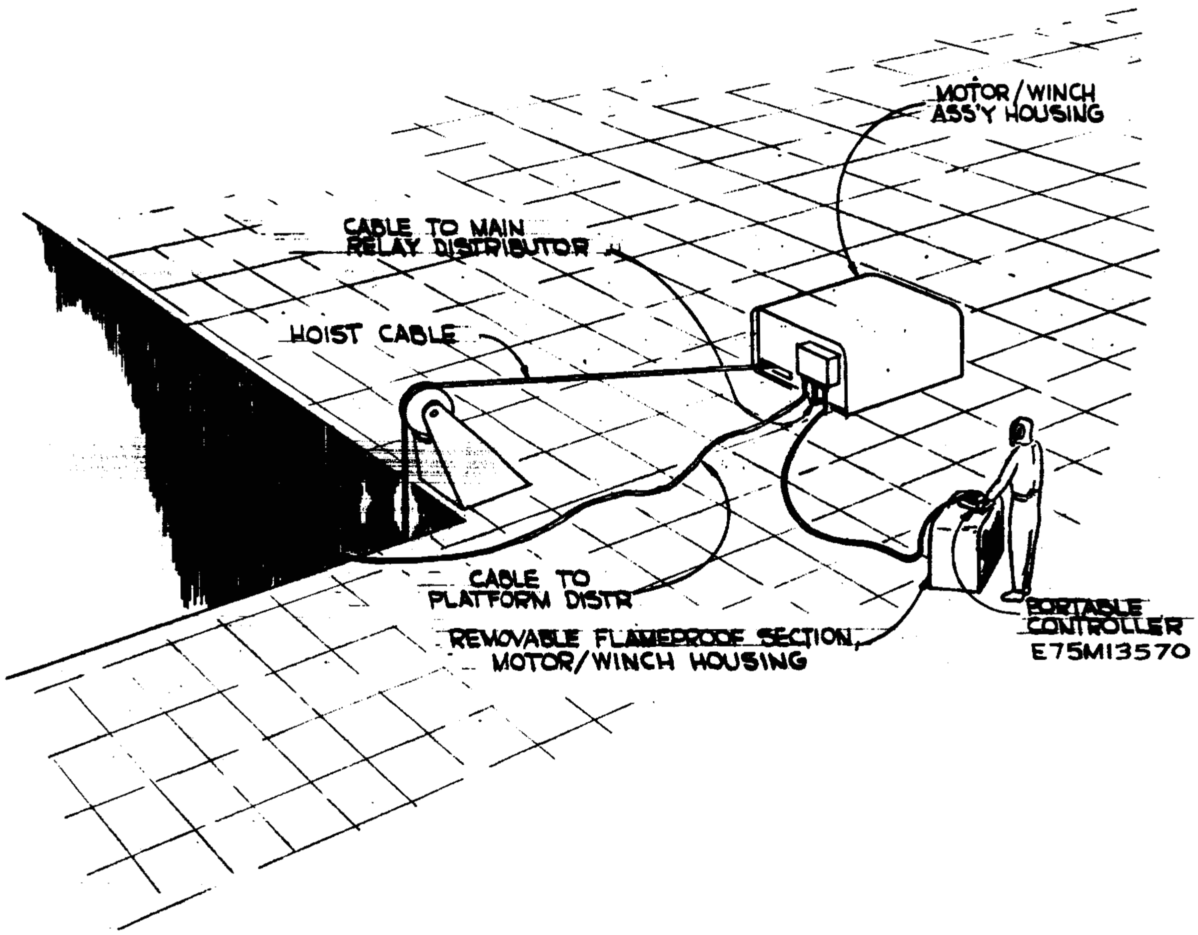


Figure 5-30. Platform Controller

protection against explosions (pad located equipment) and RFI. The top overtravel limiting system utilizes a photocell circuit which automatically cuts off the driving power when the beam is interrupted by the holddown arms when the platform is being raised.

Items (d), (e), and (f) are not used on the LUT Level Servicing Platform. This platform is positioned by the operator using the Portable Hand Controller, without monitor signals from the platform control system. A block diagram and cable interconnect for the service platforms are given in figure 5-31.

5-12. D-C POWER FOR LUT ELECTRICAL SUPPORT EQUIPMENT

The 28 volts D-C power for the LUT Electrical Support Equipment is controlled from the LCC control, Test, and Monitor Console. The 28-vdc control signals generated at the LCC are transmitted via the DDAS-Computer-Hardwire Complex to relay racks on the LUT. Racks which serve as transfer elements, interface with power distribution racks and ultimately with contactors in the distribution racks. It is through these contactors that all 28-vdc power is supplied to the various LUT Electrical Support Equipment systems.

The generation and distribution systems of the 28 vdc power for the LUT Electrical Support Equipment are as follows:

a. Service Arms. The 28-vdc is generated in the Power Supply rack using A-C facility power, and is routed to the Power Distribution Racks. This power is then distributed from the Power Distribution racks to seven Service Arms Relay Racks and to the UB Power Terminal Distributors on the Umbilical Tower via the Terminal Distributor (figure 5-32). Alternating current facility power is also used to generate D-C power for charging the batteries in the Standby Battery Rack. Standby 28 vdc battery power is automatically utilized in case of power supply failure (figure 5-33).

b. Tail Service Masts and Launcher Accessories. Development of 28-vdc power for these systems is similar to that for the service arm systems. Separate equipment is employed, however, as shown in figure 5-34. 28-vdc power from the Power Distribution Rack is routed to the relay rack for the TSM System, figure 5-35 and to the relay rack for the launcher accessory subsystems.

5-13. LAUNCHER GROUND EQUIPMENT TEST SET (GETS)

The GETS provides simulation control and monitoring functions for test or checkout of the LUT GSE. A typical setup is given in figure 5-36. Two launcher GETS units are employed. One unit is programmed to simulate the electro-mechanical components within any given ESE system. The

Figure 5-31.

To Be Provided

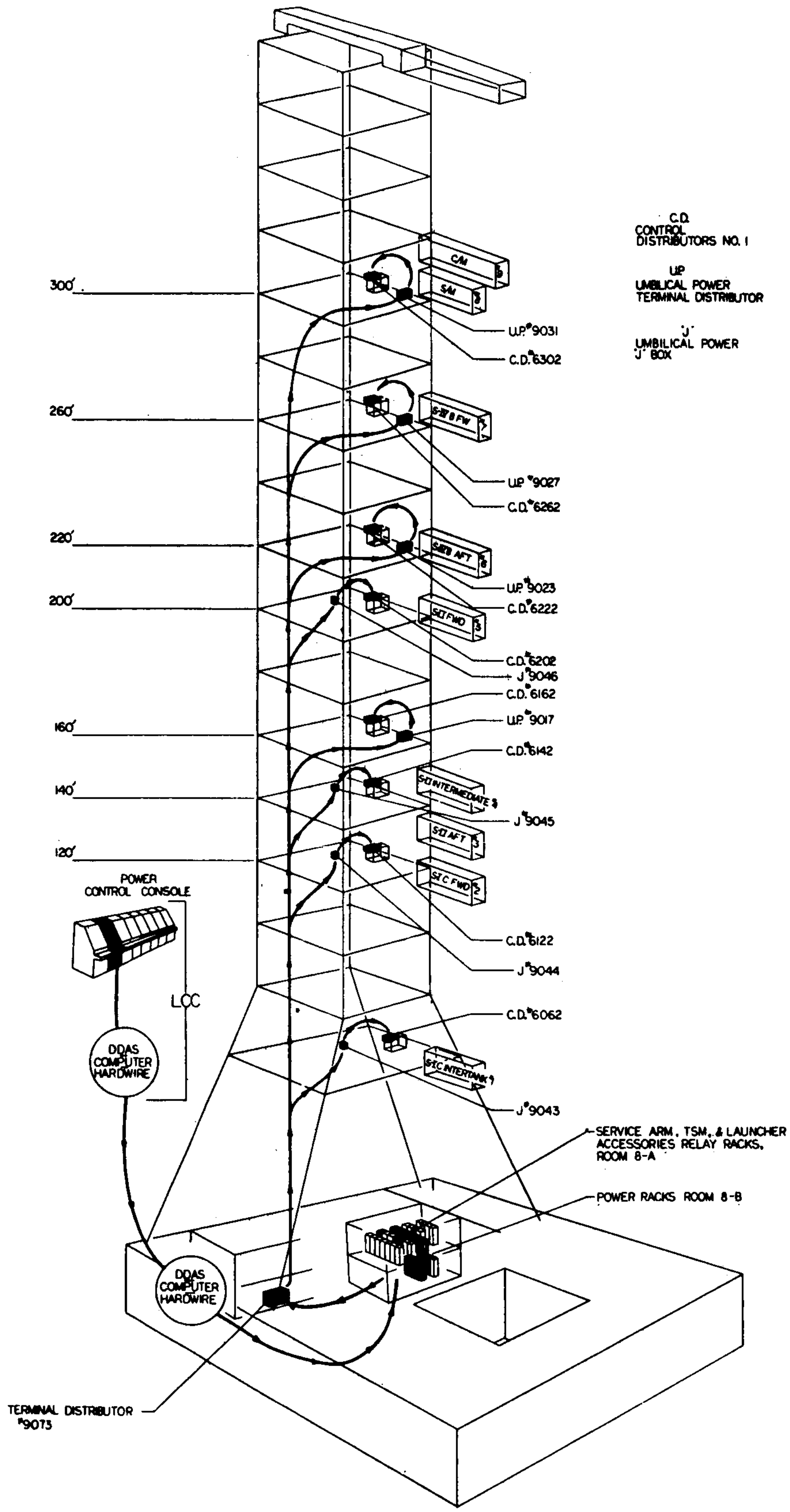
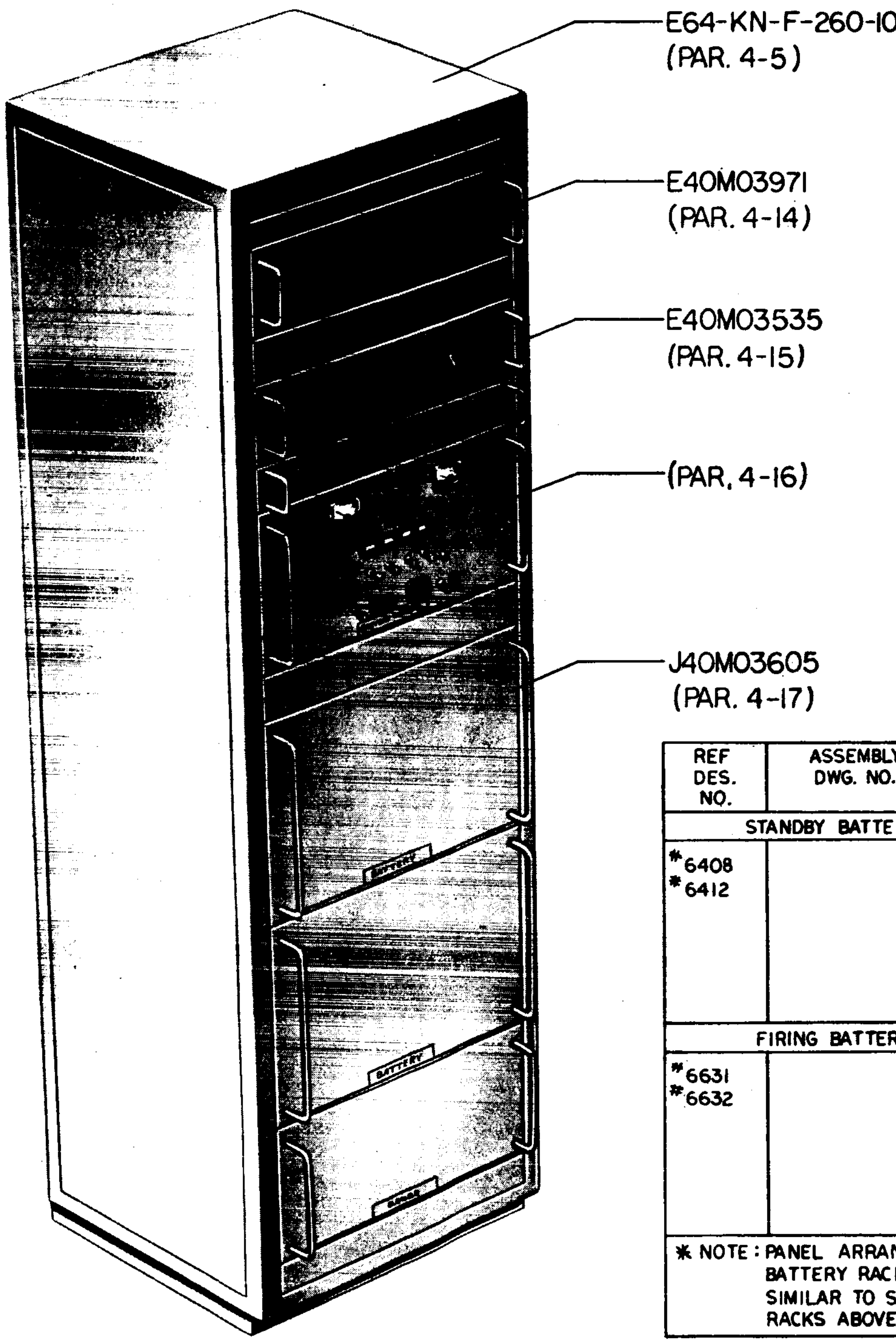


Figure 5-32. Service Arm as VDC Power Distribution



REF DES. NO.	ASSEMBLY DWG. NO.	ELECTRICAL INSTALLATION DWG. NO.
STANDBY BATTERY RACKS		
*6408 *6412		
FIRING BATTERY RACKS *		
*6631 *6632		

* NOTE: PANEL ARRANGEMENT FOR FIRING BATTERY RACKS (PAR. 3-4). SIMILAR TO STANDBY BATTERY RACKS ABOVE

Figure 5-33. Standby Battery Power System

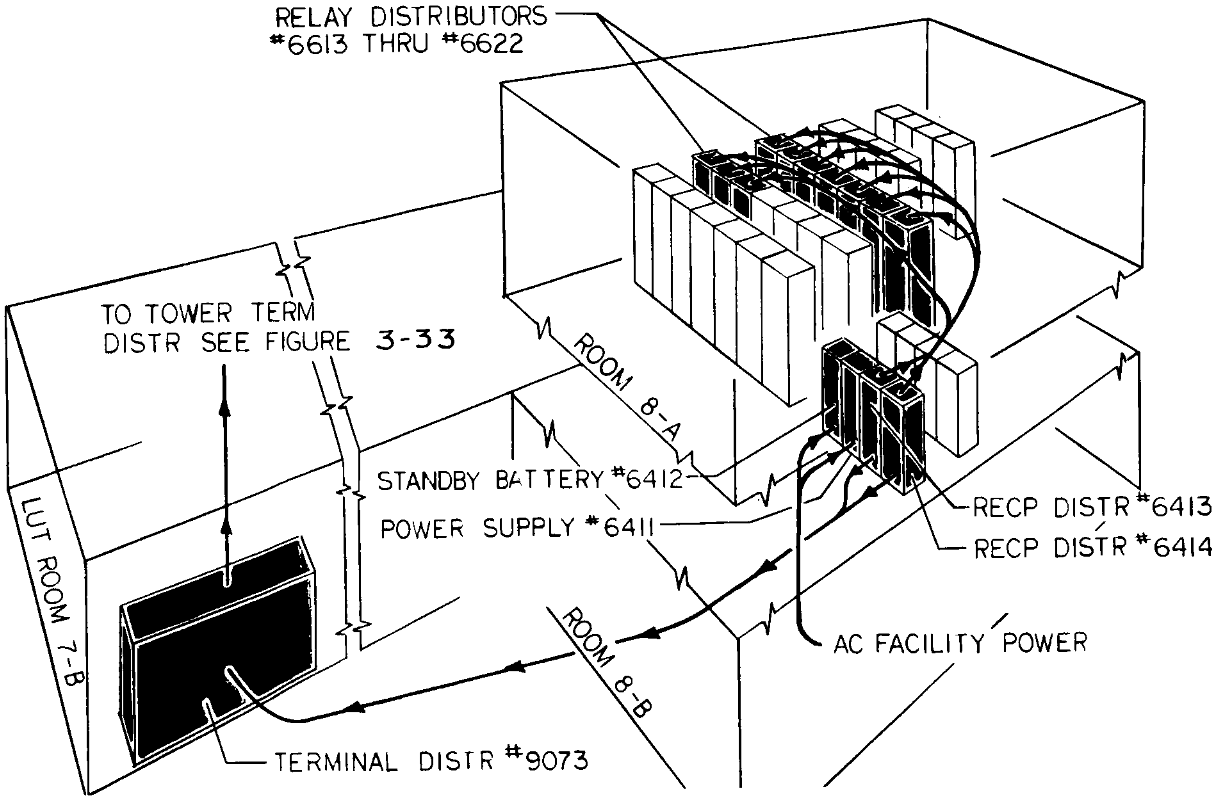


Figure 5-34. TSM and Launcher Accessories D-C Power Control

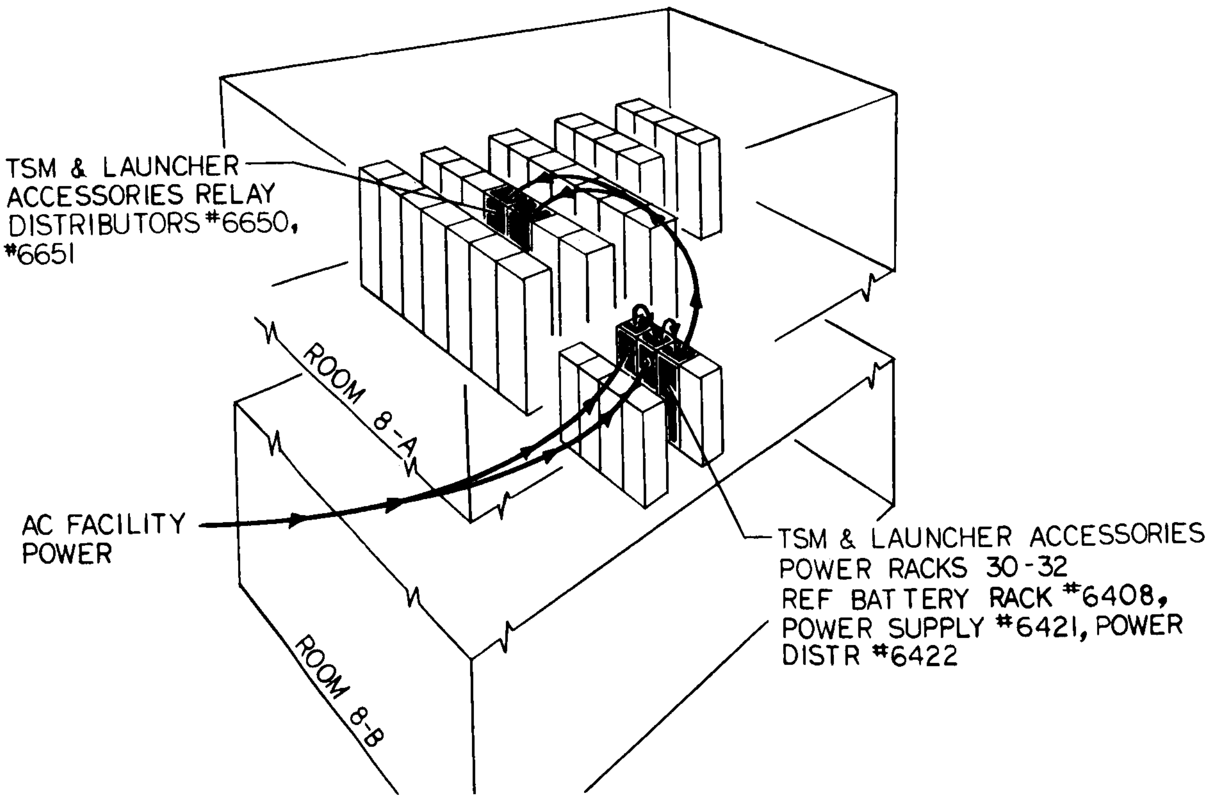


Figure 5-35. TSM and Launcher Accessories D-C Power Distribution System

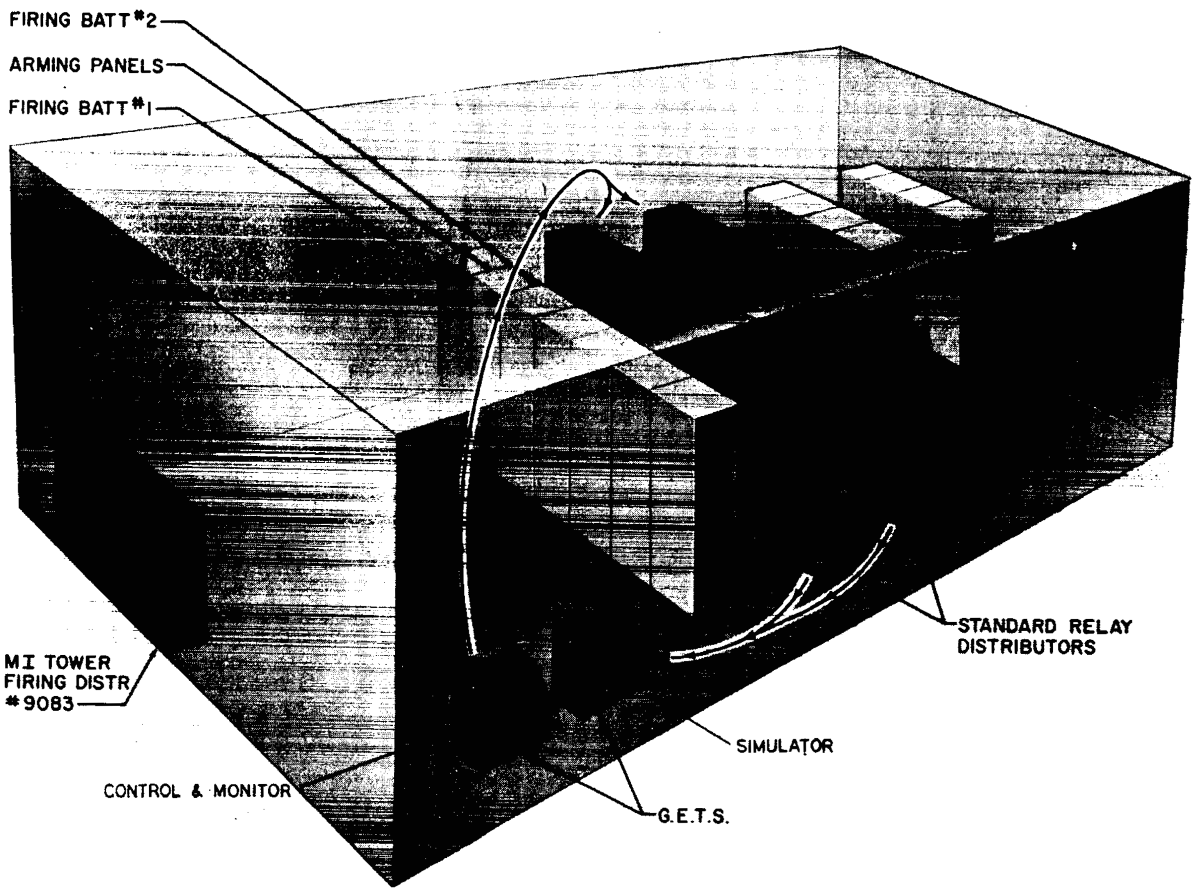


Figure 5-36. Typical GETS Installation

other unit is programmed to provide all control test and monitoring functions normally provided from the LCC. In both cases, the launcher GETS console interface, with the simulated portion of the system, is via the relay racks. The launcher GETS also has the capability of simulating the relay racks if required. An illustration of the Ground Equipment Test Set is given in figure 5-37. A more detailed presentation of the ESE covered in pagagraphs 5-4 through 5-13 is given in the Electrical Reference Handbook, LUT Electrical Support Equipment Launch Complex 39, SP-166-D.

5-14. PROPELLANTS AND GASES

The individual electrical systems for the propellant loading, high pressure gases and the environmental control system are described in a subsequent section of this document. The equipment pertinent to these systems located on the LUT consists of various distributors, patchracks, and the propellant tanking computer system computer. The propellant and gases equipment located on the LUT is given in figure 5-38.

5-15. AIR CONDITIONING AND VENTILATION CONTROL SYSTEMS

The air conditioning and ventilating systems for the LUT provides environmental protection for equipment during operations, standby time and intransit. System design is based on the following outside conditions:

a. Summer
   95° FDB 79° FWB
b. Winter
   35°F

Fueling operations at the launch area require pressurization of the compartments within the structure to 3 inches of water and the supply air to originate from a remote area free from contamination.

Requirements for the computer room are 76° FDB $\pm$ 2°F and 45% RH $\pm$ 5% at all times. The instrumentation and pneumatic areas are maintained at 75° FDB $\pm$ 2°F and 45% RH $\pm$ 5% at all times, except during transit.

During transit, the inside design conditions for the instrumentation areas are 85° FDB maximum, 40% RH maximum; for the pneumatic areas, the design conditions are 85° FDB maximum, 45% RH maximum. Pressurization of compartments during transit is not required. Ventilation for the compartments is provided to remove the heat emitted by heat-producing equipment and allows a minimum of 3 air changes per hour in all ventilation compartments except for compartments AB 6, AB 18, and AB 19. These compartments are ventilated at a rate of 39 air changes per hour.

Figure 5-37. Ground Equipment Test Set

Figure 5-38.

To Be Provided

5-16. Function of Control System. The master switch on the main panel has four positions labeled as follows:

Position one:	
Refurbish	0.1"
VAB	0.1"
Position two:	
Transit	0.1"
Position three:	
Launch	0.1"
Position four:	
Launch	3.0"

When the master switch is in Position one, the Launcher Umbilical Tower is supplied with chilled water and prime air from a remote source for the air conditioned compartments. The butterfly valves are automatically positioned to allow supply fan S-1 to provide the air for ventilating the compartments. A pressure of 0.1" of water is maintained within the compartments. Fans E-1, E-2, and E-3 operate at 1/2 speed.

When the master switch is in Position two, the butterfly valves are automatically positioned to allow supply fan S-1 to provide the air for ventilated compartments and maintain a pressure of 0.1" of water. Fans E-1, E-2, and E-3 operate at 1/2 speed. In this position, AC-1 provides cooling for compartments normally air conditioned.

When the master switch is in position three, supply fan S-1 is by-passed and the butterfly valves automatically positioned to allow the air supplied (by others) to maintain a compartment pressure of 0.1" of water. The exhaust fans E-1, E-2, and E-3 are operated at high speed.

When the master switch is in Position four, the compartment controls are reset to maintain compartments at a pressure of 3" of water.

Each compartment is supplied with air through a constant volume control box which supplies a constant cfm at all times regardless of the compartment pressure. The compartment pressure is maintained by a pressure sensing control modulating a constant volume exhaust box to vary the cfm of exhaust air leaving the compartment and maintain the desired compartment pressure. The position of the master switch sets the pressure sensing control at either 0.1" or 3.0" of water.

Temperature is maintained throughout the conditioned areas by room thermostats modulating the chilled water valves to vary the quantity of chilled water to the coil serving a given area, thus maintaining the desired temperature. The only exception is the self-contained air conditioner AC-1; this unit has its own electrical controls.

All pressurization control devices fail "open." The chilled water valves fail "closed" to the coil.

The pressure sensing devices required for various compartments are located with the other required hardware is an enclosed cabinet. The cabinet has a magnahelic or equal, pressure sensing gauge mounted thereon.

5-17. Sequence of Operation. Master Switch - A four position master switch, located in the LUT is housed in a panel similar to the electronic panels for each compartment. The switch has an engraved identification plates entitled as follows: (1) Refurbish 0.1" W.G., VAB 0.1" W.G., (2) Transit 0.1" W.G., (3) Launch 0.1" W.G., and (4) Launch 3.0" W.G. These positions control as follows:

a. Position One - Refurbish 0.1" and VAB 0.1" - The supply control units deliver the cfm required: Close the main supply ventilating air ducts (24" and 26"); close the prime air supply duct from AC-1 (18"); and close the ventilating air supply to compartment 16A (14"). Open the prime air riser (18"); open the exhaust air from conditioned space to compartment 16A (18"); and start air handling unit AHU-1. Energize supply fan S-1 and operate exhaust fans E-1, E-2, E-3, and ER-1 at one-half speed.

b. Position Two - Transit 0.1" - Position the supply control units to deliver the cfm required; close the main supply vents (24" and 26"); close prime air riser (18"); and return air from conditioned spaces to conditioner AC-1 (18"). Stop air handling unit AHU-1. Energize supply fan S-1. Operate exhaust fans E-1, E-2, and E-3 at one-half-speed; open the prime air supply duct from AC-1 (18"); open ventilation air supply to compartment 16A (14"); and open return air to AC-1 (18"). Maintain an internal pressure differential of 0.1" of water above existing atmospheric pressure; maintain compartment 15A at 75°F and other conditioned areas at 85°F.

c. Position Three - Launch 0.1": Open the valves listed as closed and close the valves listed as "open" in Position two. Stop supply fan S-1. Operate exhaust fans E-1, E-2, and E-3, at full speed. Operate air handling unit AHU-1. Energize fan ER-1 and position dampers to return air from conditioned spaces to compartment 16A.

d. Position Four - Launch 3.0": Identical to position three launch 0.1", except that the pressure differential maintained is increased to three inches of water.

Air Conditioning Unit AC-1 is a packaged unit and contains all the necessary controls, including a room thermostat mounted near the return air in the Computer Room, Compartment 15A.

5-18. Fan Coil Units. A remote temperature sensing element properly mounted to sense return air temperature only, controls a three-way motor operated valve to maintain the desired room temperature. The thermostat set point control is mounted in the unit in the space provided for the thermostat by the unit manufacturer.

5-19. Air Handling Unit AHU-1. A remote bulb thermostat with its bulb located in the return plenum from the computer cabinets modulates a three-way control valve to maintain the desired temperature.

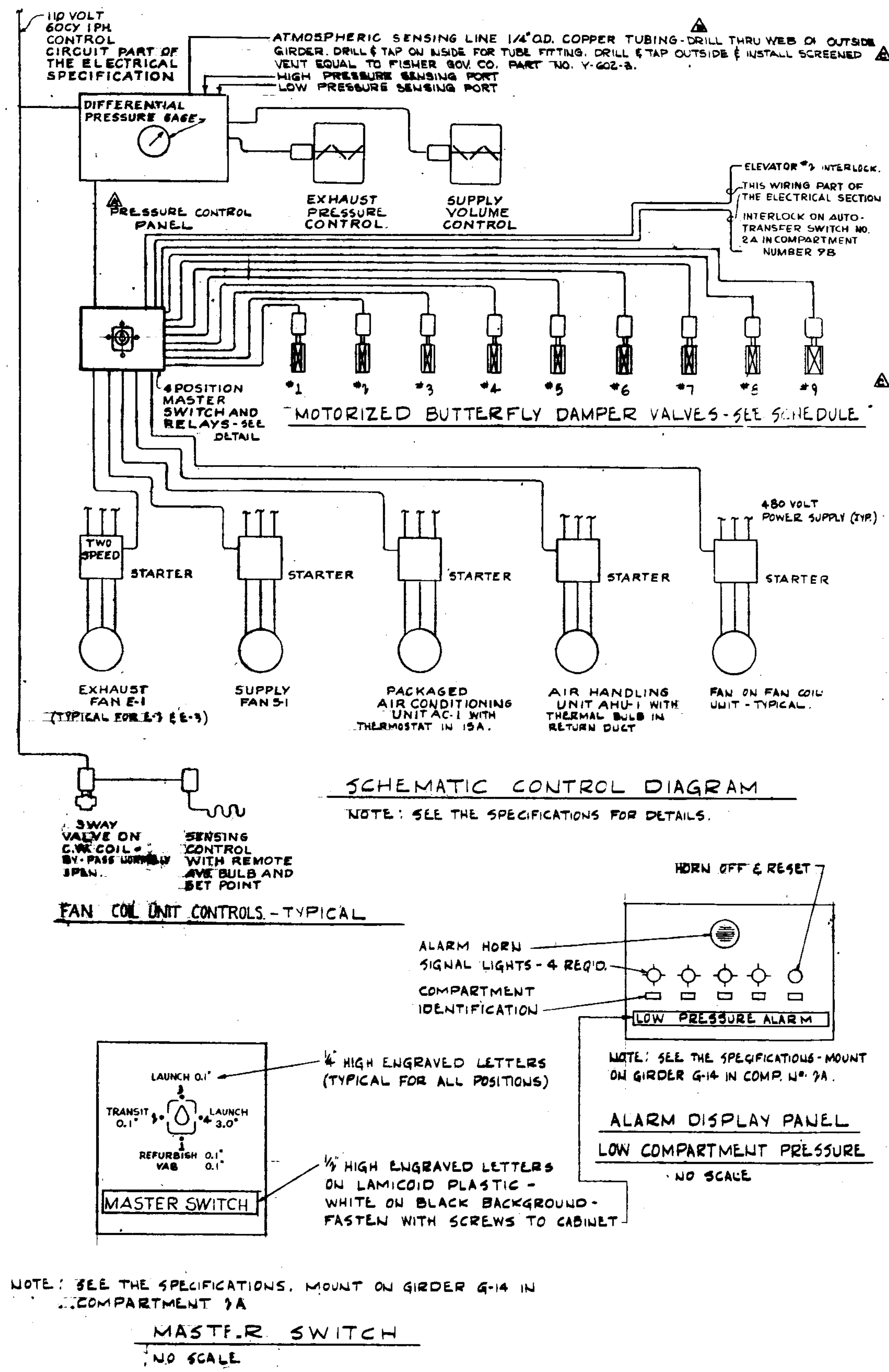
Pressure control system consisting of the master switch and the primary pressure controls operate the supply and exhaust control units to provide the pressures heretofore mentioned and the volumes required.

5-20. Pressure Alarm Monitor. The pressure sensing element located on each electronic panel, on a pressure drop below the set point, energizes an alarm circuit in the panel housing the master switch. Four (4) alarm points are provided: One for compartment 13 AB, one for Compartment 4AB, one for the Elevator Machinery Room, and one to represent any and all of the remaining compartments. All signals are sent to an onboard display panel with provisions for parallel identical remote display (by others).

The display consists of a finished panel with four different colored indicating lights properly identified as to compartments with engraved metal plates. The panel also contains an audible horn alarm. On a drop in pressure, the alarm sounds and the respective compartment light is energized. The alarm is silenced by an alarm silence button; the light remains on until the trouble is corrected. The location of the display panel is in compartment 2A. End switches on the exhaust volume control motors are not satisfactory for alarm signals. The signals are initiated by the direct sensing of all compartment pressures.

A contractor on the source of power to the motor-driven equipment is controlled from the auto-transfer switch No. 2A, in compartment 9B, and an existing interlock provided in Elevator No. 2 control system. These contacts de-energize all motor-driven equipment when the Launcher Umbilical Tower is on the crawler and elevator No. 2 is placed in use, following which use, the power supply to the equipment is automatically restored.

The air conditioning and ventilation control schematic and equipment schedules are given in figure 5-39.



SCHEDULES

AIR HANDLING UNIT

NO.	LOCATION	TYPE	FAN PERFORMANCE: TOTAL CFM	DUCT S.P. IN. H_2O	MAX. COIL S.P. "H_2O	MAX. T.S.P.	MAX. H.P.	MAX. O.V. FPM	V-PH-CY	COOLING COIL: CFM	ENT. AIR DB°F	ENT. AIR WB°F	LVG. AIR DB°F	LVG. AIR WB°F	ENT. H_2O°F	GPM	TOT. SEN. BTU/HR	GRAND TOT. BTU/HR	MIN. ROWS @ 8 FPI	MAX H_2O P.D. FT	MAX F.V. FPM	FILTER: CFM	TYPE SECT.	TYPE	MAX FILTER S.P. "H_2O
AHU-1	COMP. 15-B	DRAWTHRU	10,850	1.50	0.25	2.00	7 1/2	1600	480-3-60	5800	80	68	60	58.2	45°	25	125,700	125,700	8	3	500	10,850	V	CLEANABLE	0.15

AIR CONDITIONING UNIT

NO.	LOCATION	FAN PERFORMANCE: TOTAL CFM	DUCT S.P. IN H_2O*	MAX. COIL S.P. "H_2O	MAX. T.S.P.	MAX. H.P.	MAX. O.V. FPM	V-PH-CY	COOLING COIL: CFM	ENT. AIR DB°F	ENT. AIR WB°F	LVG. AIR DB°F	LVG. AIR WB°F	TOT. SEN. BTU/HR	GRAND TOT. BTU/HR	SUCTION TEMP.	COMPRESSOR: F.L. AMPS	KW INPUT	V-PH-CY	FILTER: CFM	TYPE SECT.	TYPE	MAX. FILTER F.V. FPM
AC-1	19-A	6000	8.5	.30	9.0	15	1600	480-3-60	6000	84.2	64.7	62.4	56.2	142.000	156.000	39° MIN.	32	19.7	480-3-60	6000	FLAT	HI.-VEL.	400

* INCLUDING FILTERS @ .4" H_2O

FAN COIL UNIT

NO.	LOCATION	FAN PERFORMANCE: TOTAL CFM	T.S.P. "H_2O	MOTOR H.P.	ENT. AIR DB°F	ENT. AIR WB°F	LVG. AIR DB°F	LVG. AIR WB°F	TOT. SEN. BTU/HR	GRAND TOT. HEAT BTU/HR	GPM	ENT. H_2O°F	MAX H_2O P.D.-FT.	CFM PRIME AIR	FILTER: CFM	TYPE
1	COMP. 15-A	2000	1.0	3/4	[illegible]	59.0	55	[illegible]	29,200	34,000	14	45°	1'	720	2000	T.A.
2	COMP. 1-A	3000	1.0	1	73.9	60.8	59	[illegible]	43,500	52,000	10.4	45°	1'	190	3000	CLEANABLE
3	COMP. 1-A	3000	1.0	1	73.9	60.8	59	[illegible]	43,500	52,000	10.4	45°	1'	190	3000	
4	COMP. 2-A	2400	.75	3/4	73.5	[illegible]	[illegible]	[illegible]	39,000	41,000	8.2	45°	1'	155	2400	
5	COMP. 2-A	2400	.75	3/4	73.5	60.7	[illegible]	[illegible]	39,000	41,000	8.2	45°	1'	155	2400	
6	COMP. 7-A	3000	1.0	1	73.9	60.8	55	[illegible]	61,300	65,300	13.1	45°	1'	275	3000	
7	COMP. 7-A	3000	1.0	1	73.9	60.9	55	[illegible]	61,300	65,300	13.1	45°	1'	275	3000	
8	COMP. 7-A	3000	1.0	1	73.9	60.9	55	53.1	61,300	65,300	13.1	45°	1'	275	3000	
9	COMP. 8-A	2400	.75	3/4	73.5	60.7	[illegible]	54.8	39,000	41,000	8.2	45°	1'	155	2400	
10	COMP. 8-A	2400	.75	3/4	73.5	60.7	[illegible]	54.8	39,000	41,000	8.2	45°	1'	155	2400	
11	COMP. 9A(MS)	2400	.75	3/4	73.5	60.7	58.5	54.8	39,000	41,000	8.2	45°	1'	155	2400	
12	COMP. 9A(MS)	2400	.75	3/4	73.5	60.7	58.5	54.8	39,000	41,000	8.2	45°	1'	155	2400	
13	COMP. 9-A(DET)	1600	.75	1/2	73.2	60.4	59	54.7	24,500	26,400	5.3	45°	1/2'	140	1600	
14	COMP. 10-A	2400	.75	3/4	73.5	60.7	58.5	54.8	39,000	41,000	8.2	45°	1'	155	2400	
15	COMP. 10-A	2400	.75	3/4	73.5	60.7	58.5	54.8	39,000	41,000	8.2	45°	1'	155	2400	
16	COMP. 7-B(MS)	2800	1.0	1	73.3	60.6	55.7	53.4	53,250	57,500	11.5	45°	1'	205	2800	
17	COMP. 7-B(MS)	2800	1.0	1	73.3	60.6	55.7	53.4	53,250	57,500	11.5	45°	1'	205	2800	
18	COMP. 7-B(MS)	2800	1.0	1	73.3	60.6	55.7	53.4	53,250	57,500	11.5	45°	1'	200	2800	
19	COMP. 7-B(MS)	2800	1.0	1	73.3	60.6	55.7	53.4	53,250	57,500	11.5	45°	1'	200	2800	
20	COMP. 8-B	2800	1.0	1	74.0	60.8	59.2	55.0	44,800	47,500	9.5	45°	1'	175	2800	
21	COMP. 8-B	2800	1.0	1	74.0	60.8	59.2	55.0	44,800	47,500	9.5	45°	1'	175	2800	
22	COMP. 21-B	2400	.75	3/4	73.5	60.7	58.7	54.8	39,000	41,000	8.2	45°	1'	155	2400	
23	COMP. 22-B	2400	.75	3/4	[illegible]	[illegible]	[illegible]	[illegible]	39,000	41,000	8.2	45°	1'	155	2400	
24	COMP. 9-B(GSE)	2400	.75	3/4	73.5	60.7	58.7	[illegible]	39,000	41,000	8.2	45°	1'	155	2400	
25	COMP. 9-B(GSE)	2400	.75	3/4	73.5	60.7	58.7	54.8	39,000	41,000	8.2	45°	1'	155	2400	
26	COMP. 10-B	3000	1.0	1	73.5	60.7	55	53.3	60,000	63,000	12.6	45°	1'	225	3000	
27	COMP. 10-B	3000	1.0	1	73.5	60.7	55	53.3	60,000	63,000	12.6	45°	1'	225	3000	
28	COMP. 10-B	3000	1.0	1	73.5	60.7	55	[illegible]	60,000	63,000	12.6	45°	1'	225	3000	
29	COMP. 10-B	3000	1.0	1	[illegible]	60.7	[illegible]	[illegible]	60,000	63,000	12.6	45°	1'	225	3000	
30	COMP. 15-B	2600	.75	3/4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.2	45°	1'	180	2600	

AIR COOLED CONDENSER

UNIT NO.	CAPACITY	MAX. COND. TEMP.	AMB. TEMP.	MAX. FAN H.P.	V-PH-CY	TYPE UNIT
ACC-1	MATCH HEAT REJECTION AC-1	125°F	95°F	2	480-3-60	VERT. DISCH.

AUTOMATIC DAMPERS

NO.	LOCATION	SIZE	TYPE	POSITION AT LAUNCH	POSITION IN TRANSIT	POSITION NORMAL
1	VENT SUPPLY DUCT	26"	BUTTERFLY VALVE	OPEN	CLOSED	OPEN
2	VENT SUPPLY DUCT	24"		OPEN	CLOSED	
3	PRIME AIR RISER	18"		OPEN	CLOSED	
4	EXH. AIR FROM COND. AREA TO COMP. 16-A	18"		OPEN	CLOSED	
5	RETURN AIR DUCT TO AC-1	18"		CLOSED	OPEN	
6	PRIME AIR SUPPLY DUCT FROM AC-1	18"		CLOSED	OPEN	
7	VENT. AIR SUPPLY DUCT TO COMP. 16-A	14"		CLOSED	OPEN	
8	EXH. AIR FROM COMP. 1-A TO OUTSIDE	5"		OPEN	OPEN	
9	OUTSIDE MAKE-UP AIR TO AC-1	6"		CLOSED	OPEN	CLOSED

FAN SCHEDULE

FAN NO.	E-1	E-2	E-3	E-4	ER-1	S-1
LOCATION	COMP. 2-B	COMP. 13-AB	COMP. 4-AB	COMP. 21-A	COMP. 11-AB	COMP. 16-B
CFM	19,130	6500	7800	260	6000	16,715
EXT. S.P. - H_2O	8"	2"	2"	[illegible]	3 1/4"	2.75"
MAX. H.P.	30	5	5	1/10	5	10
V. - PH. - CY.	480-3-60	480-3-60	480-3-60	110-1-60	480-3-60	480-3-60
TYPE MOTOR.	TWO SPEED	TWO SPEED	TWO SPEED	SINGLE SPEED	SINGLE SPEED	SINGLE SPEED
TYPE FAN	AIRFOIL	TUBULAR CENTRIFUGAL	TUBULAR CENTRIFUGAL	TUBULAR CENTRIFUGAL	TUBULAR CENTRIFUGAL	BACK. INCLINED CENTRIFUGAL
MAX. O.V. FT/MIN	2500	1650	1580	1730	1650	2200
TYPE DRIVE	BELT DRIVE	BELT DRIVE	BELT DRIVE	BELT DRIVE	BELT DRIVE	BELT DRIVE
MOTOR SPEEDS	1225 RPM	1500 RPM	1310 RPM	1140 RPM	1800 RPM	846 RPM

SILENCER SCHEDULE

UNIT NO.	CFM	MAX. P.D. H_2O	NOISE REDUCTION - DECIBELS, OCTAVE BANDS: 1	2	3	4	5	6	7	8	TYPE	SIZE	REMARKS
DS-1	13,300	1."	12	16	25	37	45	[illegible]	43	35	DUCT	34x38x60	
DS-2	6,650	1."	12	16	25	37	45	[illegible]	43	35	"	21x28x60	
DS-3	6,650	1."	12	16	25	37	43	48	42	35	"	21x28x60	
DS-7	720	0.1"	10	12	16	20	30	46	32	23	"	12"D. x 36L	2 REQUIRED
			CYCLES: 100	200	300	400	500	1000	2000				
DS-4	6,500	2.0	35	45	53	55	54	[illegible]	[illegible]	—	"	36x18x168	
DS-5	7,850	2.0	35	45	53	55	54	[illegible]	[illegible]	—	"	40x18x168	
DS-6	19,130	2.0	35	45	53	55	54	[illegible]	[illegible]	—	"	30x18x168	

Figure 5-39. Air-Conditioning and Ventilation Control Schematic and Equipment Schedule

5-21. WATER FOGGING CONTROL SYSTEM

For protection of personnel and the Umbilical Tower structure resulting from spillage of cryogenics, a water fogging system is provided. The system has a separate header and nozzle system on the four tower levels. The tower riser pipe will be normally pressurized. A two position, electro-hydraulic water supply valve serves the nozzle header system at each tower level. Supply valves are operated via manual push button switches located at each fogging level, at level "O" and within the Launcher. An emergency hand control valve is provided at each tower level which opens the water supply valve on only that level. Circuits are included for water supply valve operation remote from the Launcher. The water supply valves at each tower level are arranged for approximately simultaneous opening (and closing) via energization of the valve control circuits by means of any of the manually operated push buttons, or the control station (by others) which are located remotely from the Launcher Umbilical Tower.

5-22. Water Supply Control Valve. Each nozzle header water supply valve is electrically controlled via a 28-volt direct current dual solenoid pilot valve which ports the upstream water pressure to open (and to close) the 6-inch diaphram type, 300-pound ASA standard flanges, steel body, 2-way globe valve.

5-23. Features and Accessories. The valves have lockable speed control devices for opening (3 seconds) and closing (10 seconds) rate adjustment and are equipped with devices to monitor two positions of the valve stem which close electrical contacts provided to initiate a 28-volt signal circuit to indicate the open (and closed) position of the valve.

5-24. HAMMERHEAD CRANE CONTROL SYSTEM

5-25. Hoist Drive and Controls. Control of the main hoist drive is of the direct current adjustable voltage type and includes a totally enclosed squirrel-cage motor, a totally enclosed D-C generator and adjustable static exciter and voltmeter.

The drive system for hoisting and lowering utilizes a compound wound hoist motor to provide a speed varying inversely with the hook load.

The power unit includes a motor generator set, the motor of which is rated at not less than 100-hp.

The hoist brake is a floor mounted D-C shoe brake.

5-26. Trolley Drive and Controls. This system is of the A-C wound rotor, static speed control type using a saturable reactor in the secondary circuit to give speed control. Torque reversal is accomplished by means of primary contactors. The system provides for each direction a five-point stepped non-regulated speed control of the trolley motion. The motor has special duty crane drive rating of 5-hp.

5-27. Swinger Drive and Control. In general, this equipment is of a similar design as that of the trolley drive and control.

5-28. UMBILICAL TOWER ELECTRIC ELEVATORS CONTROL SYSTEMS

The elevators are of the gearless hoist type. Each hoist machine is of the gearless traction type and consists of a motor, traction sheave and brake, compactly grouped on a single shaft.

Each hoist motor is of the direct current, slow speed type designed to develop high starting torque with low starting current.

Each hoisting machine is provided with an electro-mechanical brake.

Each elevator has a generator field control consisting of an individual motor generator set, controller and automatic starter.

The controllers provide the following features:

a. Permit reversal of the elevator motor without opening the armature circuit and without discomfort to car passengers.

b. Automatically limit current applied to elevator hoisting motor to that required for the actual specified duty and prevent overload or excessive current to elevator motor.

c. A time delay adjustable to at least 15 seconds holding time to allow passengers to leave or enter the car.

d. An automatic safety magnet which cuts off the current automatically, causes the brake of the hoisting machine to be applied and brings the car to rest upon current failure from any cause or upon operation of any of the various safety devices.

SECTION VI
CRAWLER/TRANSPORTER

6-1. GENERAL

The crawler/transporter electrical systems consists of the propulsion power and control system, the hydraulic control system which includes the steering control, the leveling control, equalization control, and jacking control subsystems and the A-C power system. The equipment layout is illustrated in figure 6-1.

6-2. PROPULSION

The propulsion system of the crawler/transporter consists of sixteen (16), 375-hp, D-C, mill-type motors situated in groups of four (4) on each set of trucks. The armature of one motor in each set of trucks is connected in series to form a loop of four motors, resulting in a formation of four (4) drive motor loops. Each loop is energized by one each of four 1000-kw, D-C generators coupled in pairs to two (2) 2720-hp ALCO Diesel engines. The fields of the motors and the generators are independently excited by two field exciters consisting of a 21-kw generator for the four 100-kw generators and 85-kw generators for the sixteen drive motors. The exciters are driven by one (1) A-C motor supplied by the transporter A-C power system which will be covered separately.

The propulsion system is capable of the following functional requirements:

a. Forward and reverse propulsion controlled from either of two control cabs, located at each end of the transporter with provision for transferring control to either cab.

b. The control system is arranged such that regardless of the action of the operator on the controls, the rate of acceleration of the transporter shall not exceed a certain prescribed limit.

c. The response of the regulating system must be such as to preclude acceleration or deceleration of the transporter in excess of the prescribed limit.

d. The normal speed of the transporter is one mile per hour with a maximum speed of two miles per hour.

The single line propulsion system schematic is given in figures 6-2 through 6-5. The basic operation of the system is as follows: The tractive

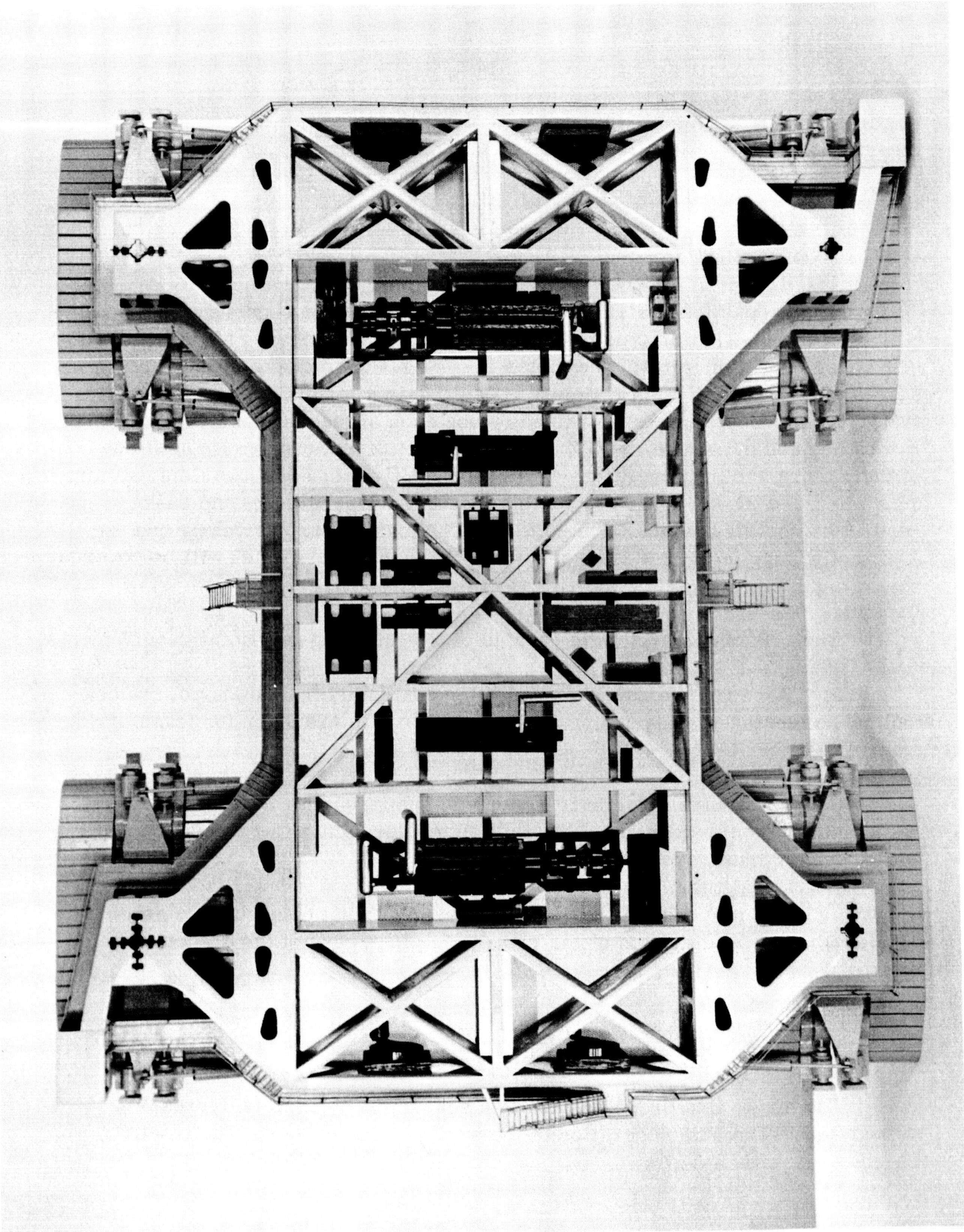


Figure 6-1. Crawler/Transporter Equipment Layout

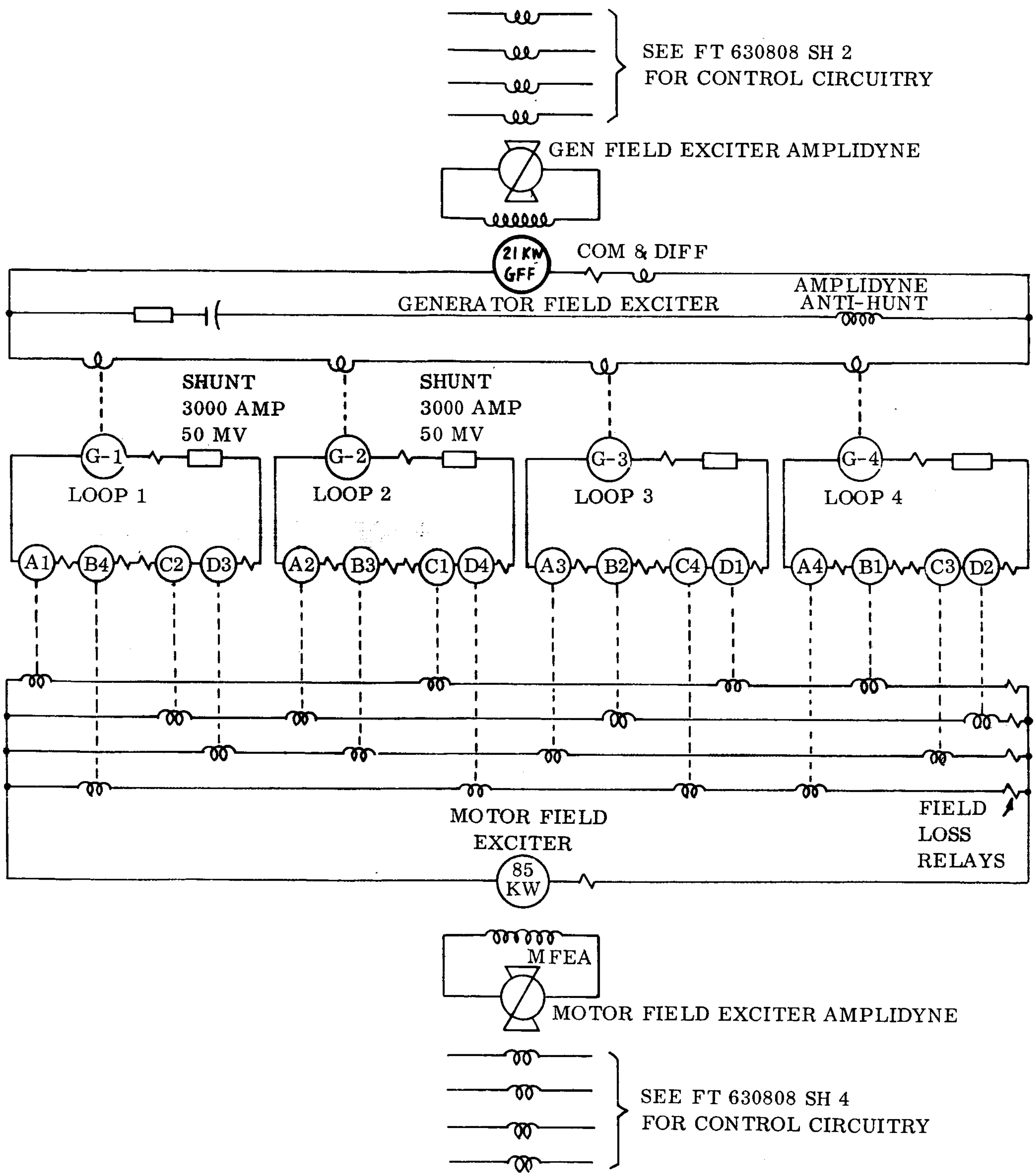


Figure 6-2. Single-Line Propulsion System Schematic

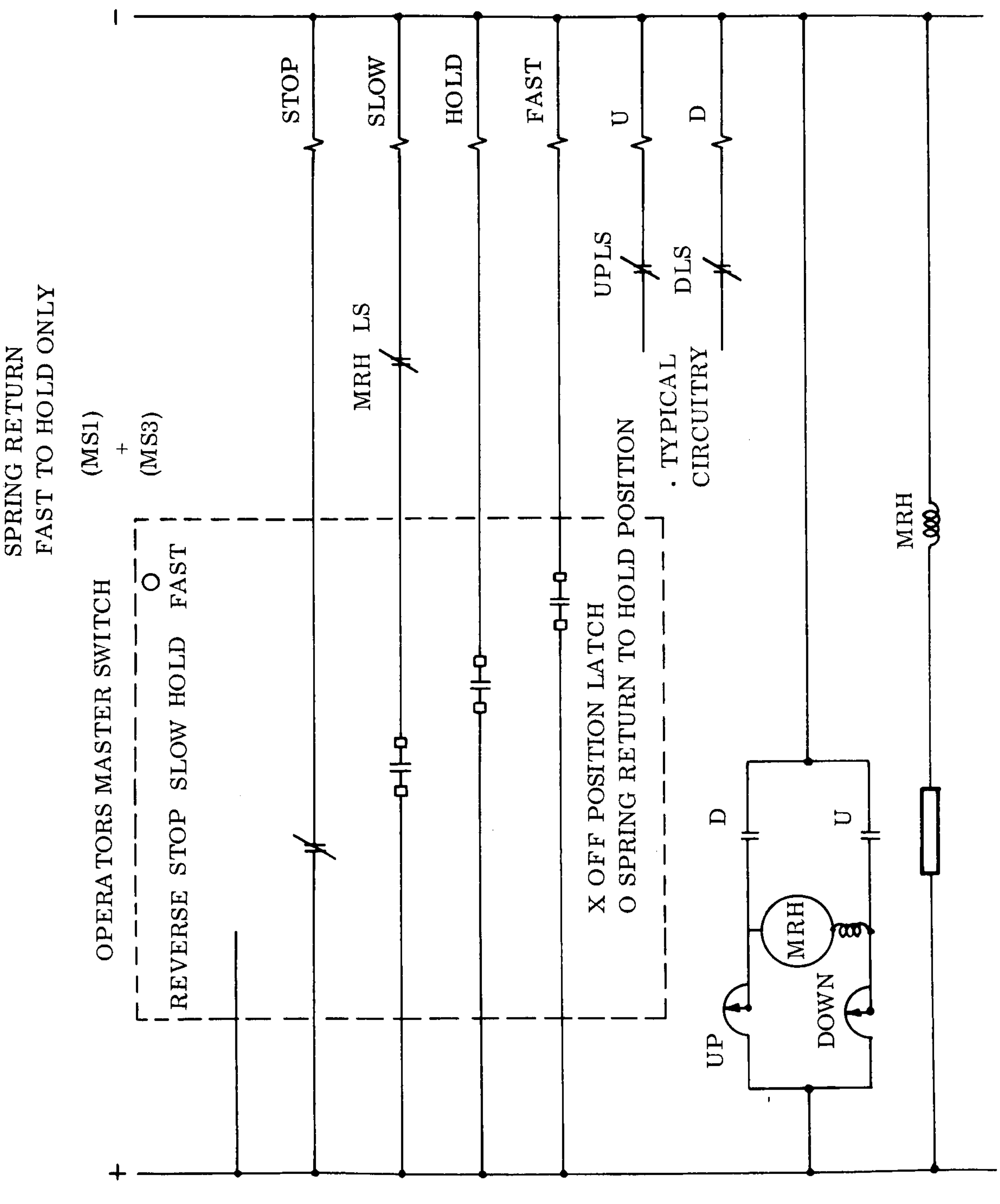


Figure 6-3. Single-Line Propulsion System Schematic

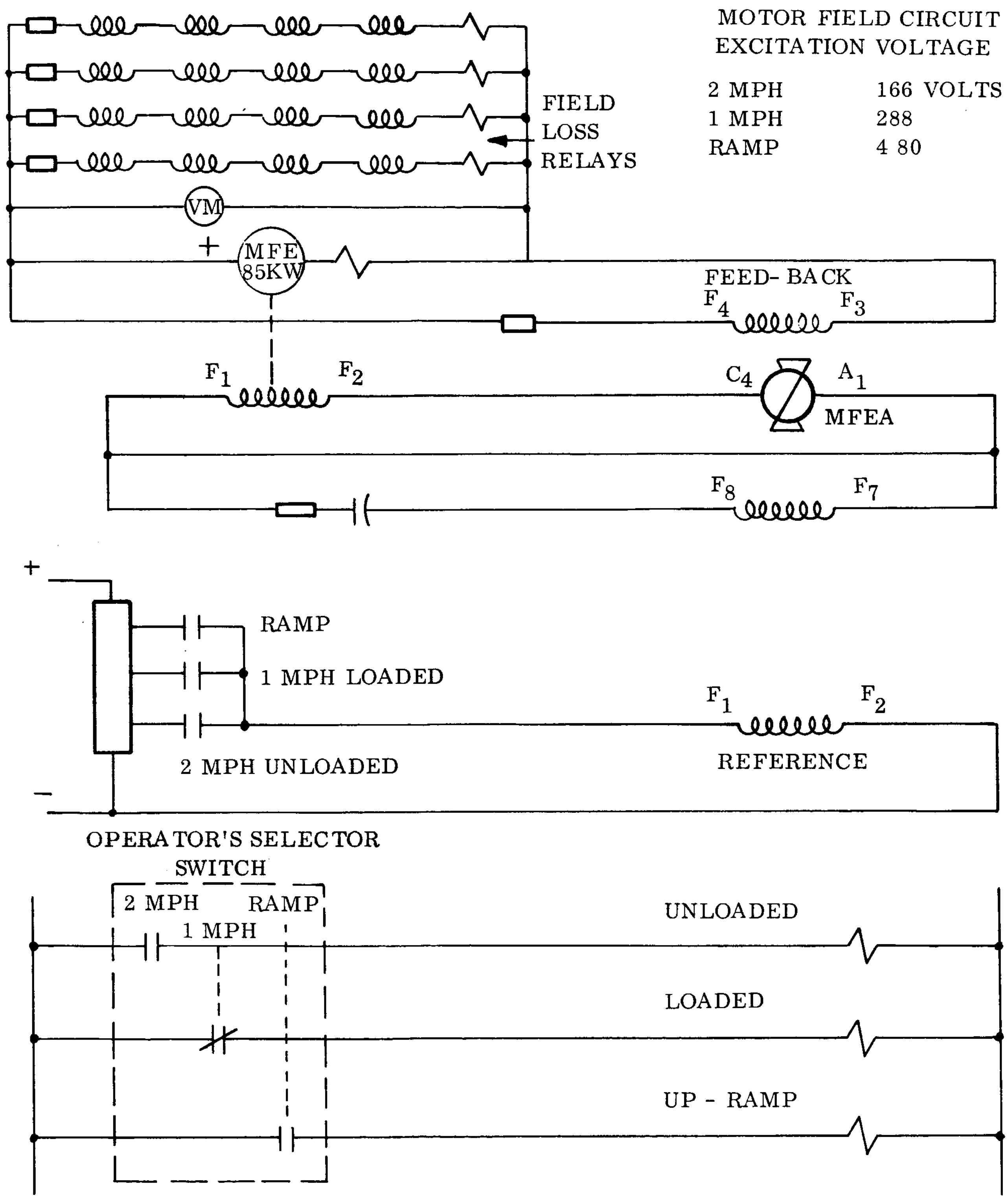


Figure 6-4. Single-Line Propulsion System Schematic

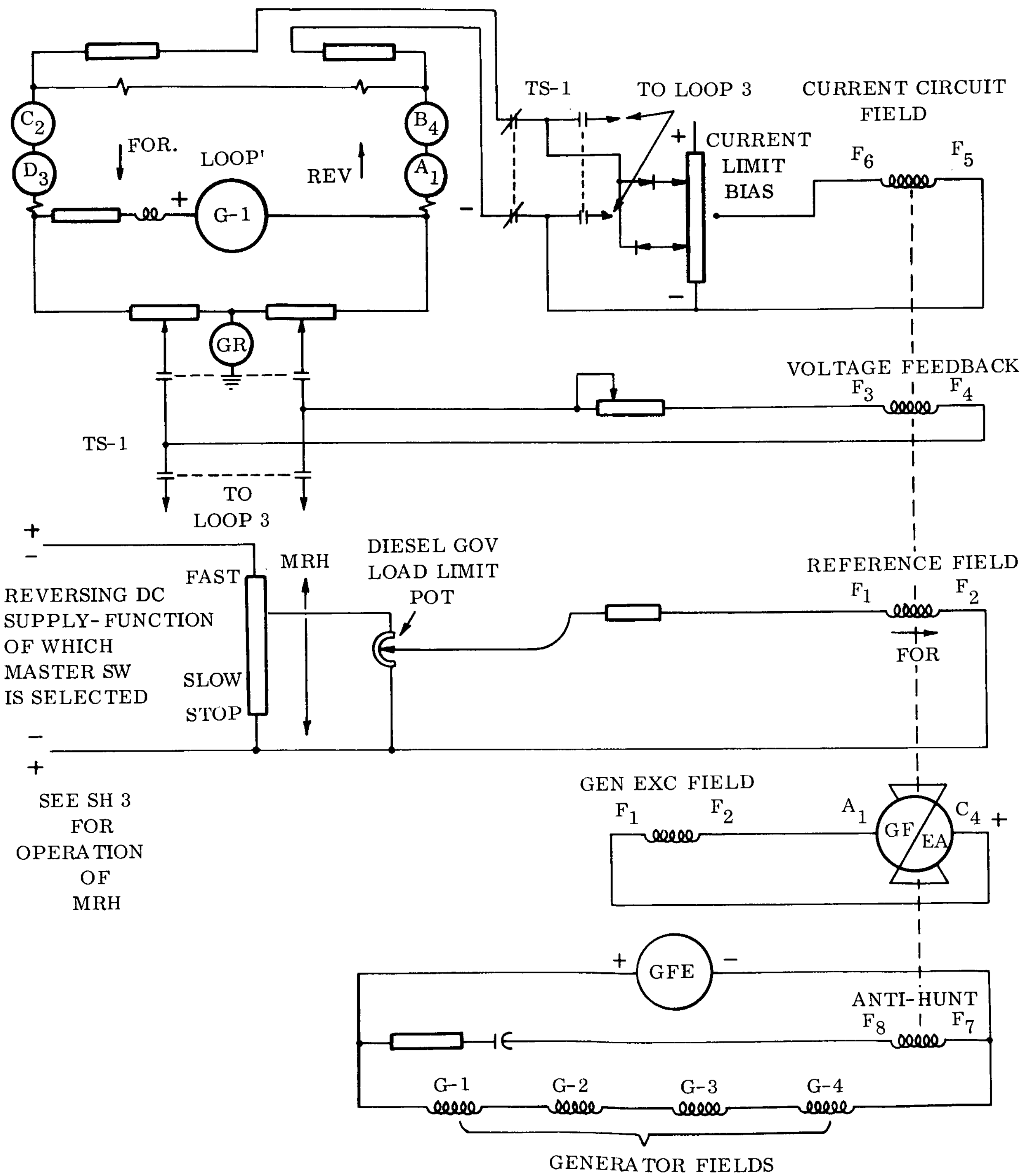


Figure 6-5. Single-Line Propulsion System Schematic

power is furnished by the four 1000-kw, D-C generators which supply the armature current to the sixteen drive motors. The drive motors are controlled by: (1) Adjusting the armature current which is controlled by the output of the field exciter to the 1000-kw, D-C generators. This is accomplished by adjusting the reference field voltage of Amplidyne #1 with the motor operated rheostat controlled by the Operator's Master Switch; (2) Adjustment of the drive motors field exciter output with the Operator's Selector Switch which controls the voltage reference field of Amplidyne #2. The amplidynes also regulate the system by functioning as amplifiers and magnetic field input comparators The field inputs are compared magnetically in the amplidynes with the net difference or error signal between the inputs providing the amplidyne excitation. The output of the amplidynes in turn energizes the field of the 1000-kw generators (Amplidyne # 1) exciter and the drive motors' field exciter (Amplidyne # 2) which by controlling the 1000-kw generator outputs and drive motors' field current, controls the speed of propulsion and also maintain stability within the established limits.

Should a failure of one of the 2750-hp Diexels occur, the drive motor sets affected can be connected in series to the remaining set, whereby they are capable of operating at half power.

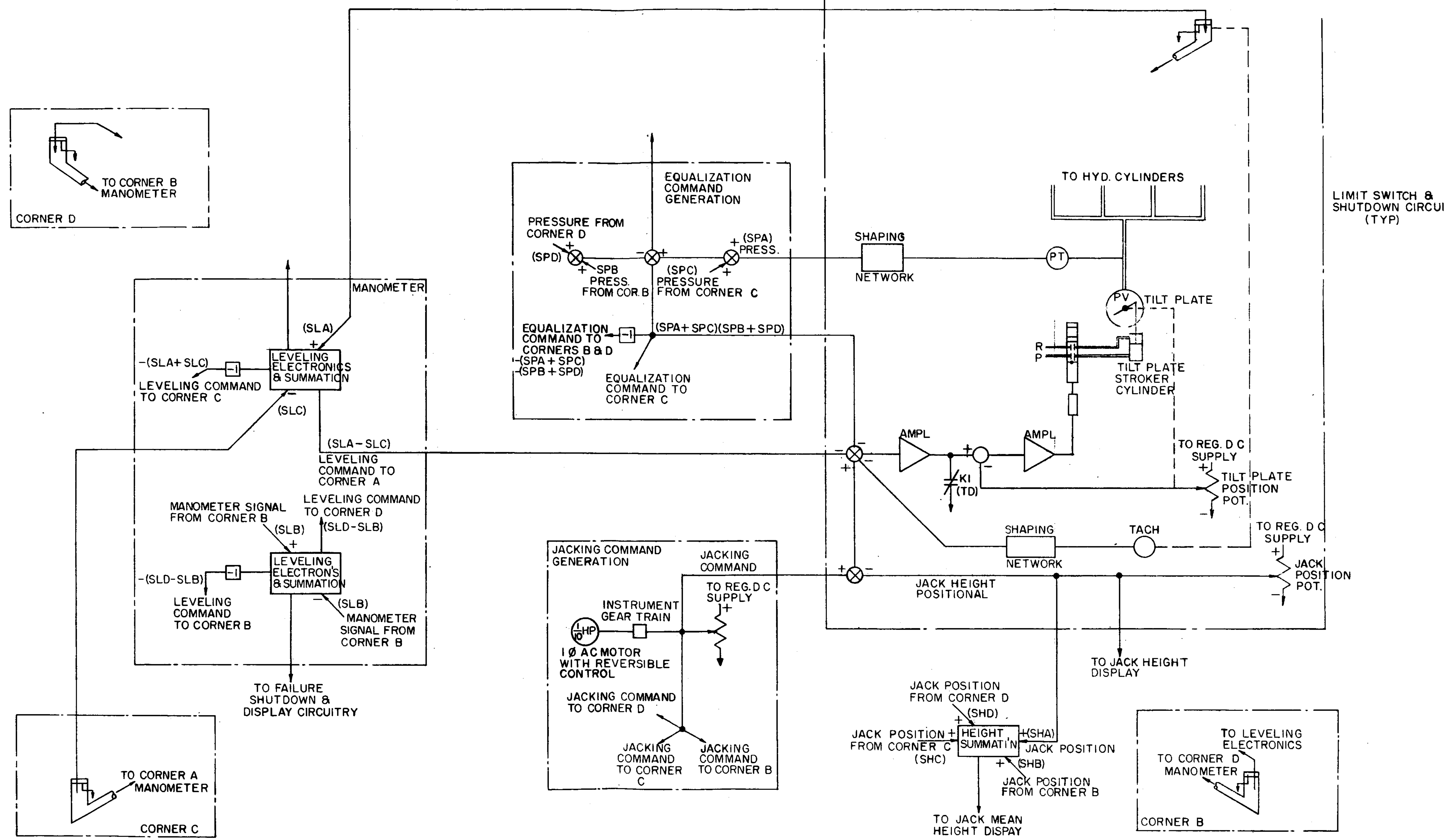
6-3. JACKING, EQUALIZATION AND LEVELING HYDRAULIC CONTROL SYSTEM (J.E.L.)

The jacking, equalization, and leveling hydraulic pumps are driven by two 150-hp, 1200-rpm, A-C electric motors. Two pumps and one motor providing the main power pack for each pair of diagonal corners. A complete duplicate set, including associated hardware and plumbing, is provided for redundance to a point of common input to the corner hydraulic cylinders.

6-4. JACKING CONTROL SUBSYSTEM

Simultaneous extension or retraction of the corner support cylinders for raising or lowering the chassis is provided by the jacking control subsystem. This function will normally be accomplished only when steering is not required. Controls for jacking and lowering are located in each operator cab. Limit switches and shutdown circuits are provided at each corner to prevent bottoming of the cylinders in the fully retracted or extended positions. Jacking inputs is applied to each corner of each leveling axis. The chassis level is maintained by the leveling system.

The jacking control schematic is given in figure 6-6. The jacking command is initiated by adjusting a regulated D-C voltage input by means of a motor operated rheostat to a summation circuit (adder) which also receives a D-C



1. KI IS TIME DELAY RELAY WHICH CENTERS PUMP TILT PLATES UNTIL MOTORS ARE UP TO SPEED.
   KI IS EXCITED WHEN SUPERCHARGER POWER PACKS IS STARTED.
2. FOR SERVO CONTROL SYSTEMSDESCRIPTION OF OPERATION SEE SUPPLEMENTARY DISC. SIO-T

1. JACKING
2. EQUALIZATION
3. LEVELING

Figure 6-6. Jacking Control Schematic

voltage input from the jack position potentiometers. Its output is applied to another adder which is also tied to the leveling summation networks and equalizing command circuits. The output from this adder is amplified, compared in a summation circuit with the tilt plate position potentiometer output, and then further amplifield to operate the servo control which actuates the tile plate on the hydraulic pump. The jacking rate is 1/16 inch per second.

6-5. EQUALIZATION CONTROL SUBSYSTEM

Equalization is the function of the support cylinder hydraulic system to provide the proper balance of load among the four supporting corners. Therefore, the hydraulic equalization system will adjust the sum of the loads on one diagonal axis to equal the sum of the loads on the other diagonal axis. Pressure transducers attached to pilot lines on the manifolds of the corner support cylinders sense the hydraulic pressure in the support cylinders. The equalization control schematic is included in figure 6-6. Essentially the system operates as follows: Signals from each corner pass through a shaping network. Then the inputs from the corners of each axis are summed together in two separate adding circuits and compared to each other. When a differential output appears, a signal is transmitted to the summing circuit which controls the tilt plates of the hydraulic pumps, balancing the loads on each axis.

6-6. LEVELING CONTROL SUBSYSTEM

The chassis of the crawler/transporter is leveled by adjustment of the diagonal corner support cylinders. Level sensing is provided by two diagonally located pressure type manometers whose horizontal tubes are approximately 130 feet long. Errors in level are sensed from the manometers by pressure transducers and transmitted to summation circuits as shown in figure 6-6. Outputs transmit leveling commands to the adder which also receives the inputs from the jacking, equalization, and leveling networks and generates a signal to the corner cylinder servo system adjusting the corner level accordingly. The rate of leveling will not exceed 1/2 inch per second.

6-7. STEERING HYDRAULIC SYSTEM

The steering hydraulic system consists of two pump and motor sets, each set containing a 150-hp, 1800-rpm, A-C electric motor driving two (2) constant speed, variable flow, servo-controlled hydraulic pumps. Under normal operation, both sets function together as a unit, however, under emergency conditions, either set can be shut down and the system adjusted to operate on the remaining set.

6-8. STEERING CONTROL SYSTEM

Steering is accomplished by actuation of a pair of double acting tail rod cylinders located on each truck assembly. Fore or aft cab steering control is assigned from the control room. A rear steering correction override switch is provided in each cab. This switch transfers control of the rear wheels to the rear cab operator. In the manner of the steersman on a ladder truck, this permits him to steer the rear tracks independently in rounding a curve, so as to prevent the rear end from slewing off the roadway. The steering control schematic is given in figure 6-7. A schematic of the steering logic circuits is also given in figure 6-8. A steering mode selector control is provided to permit a choice of great circle or crab steering as the conditions may require. Steering commands from the operator cab are applied through the steering control lever. The steering circuit is activated from the control room. Control is given to the cab facing the direction of travel. The center position of the control is set for normal steering. Positioning the control stick to the right applies a more positive signal to a summing circuit for moving the trucks to the right. Positioning the control stick to the left applies a less positive signal for moving the trucks to the left. The output from the summing circuit is fed to an amplifier which actuates the motor operated rheostats tapered to provide the selected mode of steering (Ackermann or Linear). Output from this point is applied to a summing circuit together with the input from the crawler position potentiometer. The output from this circuit is amplified and applied to two more adders in series which sums the signal with an input from the steering mode lockout cam. This output is summed with the pump stroke position feedback. The output from this point is amplified and applied to the servo-controlled tilt plate on the hydraulic pump which adjusts the position of the trucks accordingly. Displays of the steering control data are located in the control room and both operator cabs.

6-9. HYDRAULIC SYSTEM SUPERCHARGER

The hydraulic systems supercharger consists of two pump and motor sets, each set containing a 20-hp, 1800-rpm, A-C electric motor driving two hydraulic pumps; one of which is a fixed displacement type and the other is a variable displacement pressure compensated type. Under normal operating conditions, both sets function as a unit but in an emergency either set can be shut down, and the system adjusted to operate on the remaining set.

The hydraulic systems supercharger must function in order to operate the jacking, equalization, leveling steering system.

Each supercharger set contains one high pressure hydraulic pump and one low-pressure hydraulic pump. The high pressure pump supplies hydraulic fluid at 2000-psi which provides the control pressure to actuate the servo valves

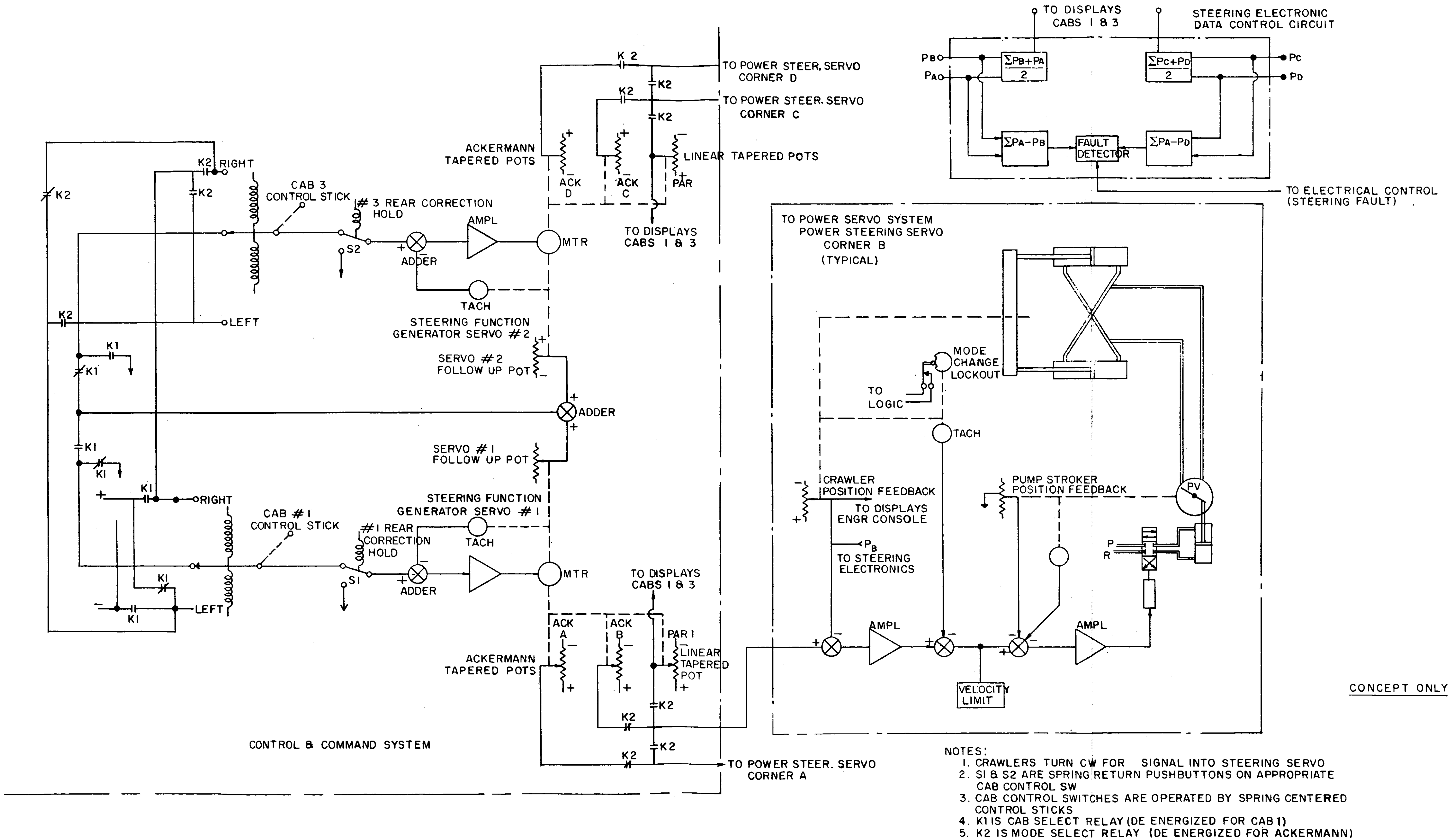


Figure 6-7. Steering Control Schematic

Figure 6-8.

Foldout

To Be Provided

on the jacking, equalization, and leveling systems and the steering systems. The high pressure system also provides the control pressure for the isolation and locking valves in the jacking, equalization, and leveling system. Pressure to the isolation and locking valves is controlled by electric solenoid valves.

The low pressure pump supplies the positive head for the jacking, equalization and leveling systems' and the steering systems' hydraulic pumps.

6-10. ELECTRIC POWER SYSTEMS

6-11. DIRECT CURRENT SYSTEM

The D-C power system consists of four (4) 1000-kw generators coupled in tandem to two (2) 2750-hp ALCO diesel engines. The generators furnish the propulsion power for the drive motors. Field excitation for the 1000-kw generators is provided by one 21-kw, D-C generators. Field excitation for the D-C drive motor is provided by one 85-kw generator. Both excitation generators are driven from a common 150-hp, A-C motor. D-C control power for all systems on the crawler/transporter is obtained by rectifiers connected to the A-C system.

6-12. ALTERNATING CURRENT SYSTEM

Intransit A-C power for the crawler/transporter is provided by two (2) alternators rated at 750-kw at a 80% power factor. Each alternator is driven by a 1076-hp diesel engine. The power is 3Ø, 60 cycle, 277/480 volts. Standby power, utilized when the crawler/transporter is parked and for start up requirements, is obtained from an outside source by means of a reel-in type extension cable. An A-C auxiliary power system is located on the crawler/transporter consisting of two (2) alternators rated at 150-kw at a 80% power factor. Each alternator is driven by a 300-hp diesel engine. The A-C auxiliary system provides power for the LUT during transit to the pad. A single line schematic for the crawler/transporter A-C power system is given in figure 6-9.

The crawler/transporter A-C power systems is utilized for operating the following equipment.

a. Lubrication oil pumps - eight (8) 1-1/2-hp, A-C motors which drive pumps supply lubricating oil to the gear trains on the trucks. Two units are located, one fore and one aft, on each set of trucks.

b. Steering Hydraulic System - two (2) 150-hp, A-C motors.

c. J.E.L Hydraulic System - four (4) 150-hp, A-C motors.

d. Diesel Radiator Fans - two (2) 75-hp A-C motors for the 2750-hp diesels. Two (2) 15-hp, A-C motors for the 1076-hp diesels.

e. Supercharger Hydraulic System - two (2) hp, A-C motors.

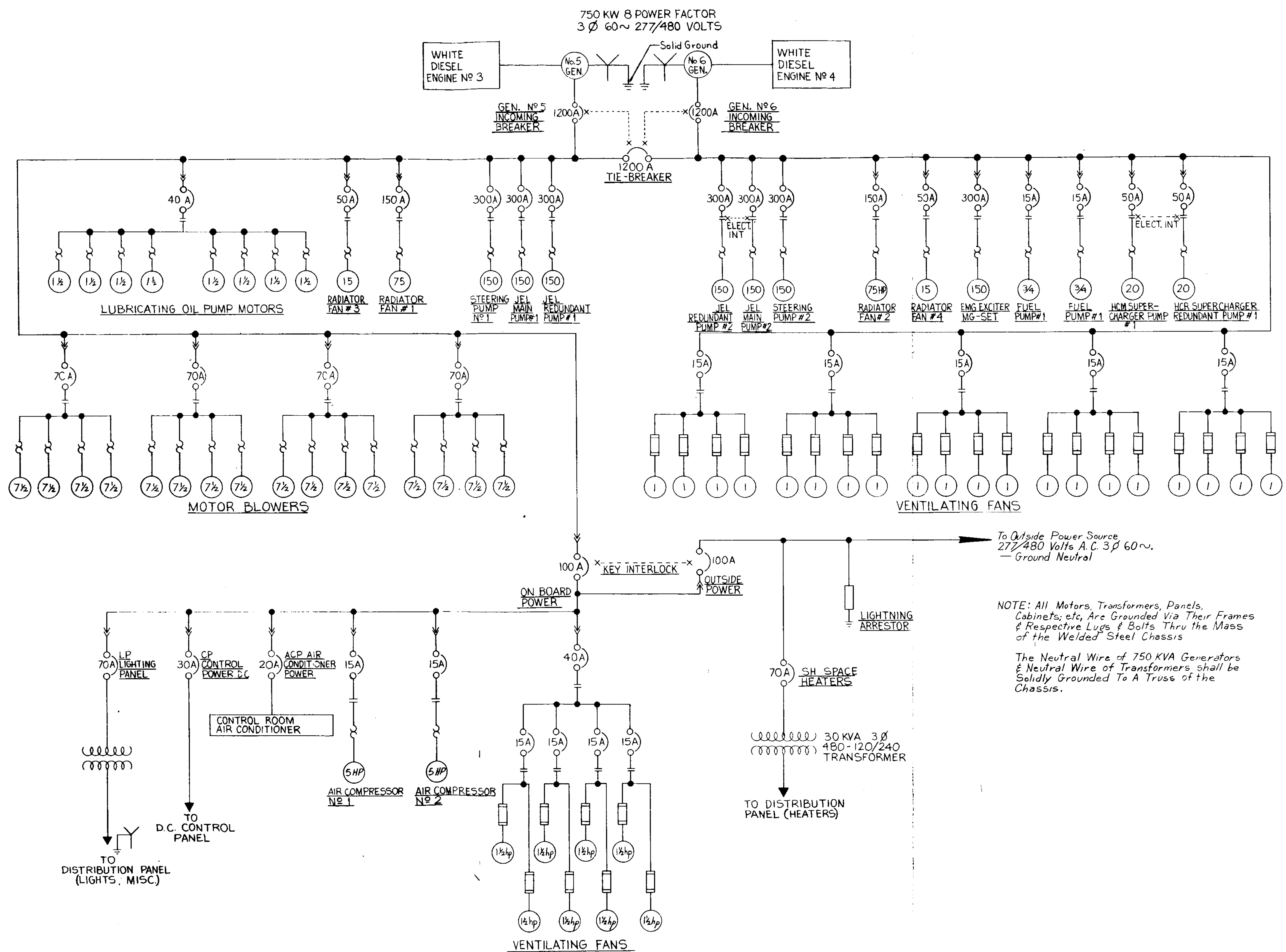


Figure 6-9. Crawler/Transporter A-C Power System Single-Line Schematic

f. Diesel Fuel Transfer System - two (2) 3/4 hp motors which operate pumps which transfer diesel fuel from the fuel reservoirs to the diesel engine tanks.

g. Exciter MG Set - one (1) 150-hp, A-C motor.

h. Drive Motor Blowers - sixteen (16) 7-1/2-hp, A-C motors. The blowers provide supplementary cooling air to the fan cooled drive motors.

i. Ventilating Fans - sixteen (16) 1 hp, A-C motors, eight (8) 1-1/2-hp, A-C motors for cooling and ventilating the crawler/transporter.

j. Air Compressors - two (2) 5-hp, A-C motors for diesel start air compressors.

k. Heaters, Space and Equipment - 30-kva, 3Ø, 208/120 volts.

l. Air Conditioners - three units, one for each cab and one for the control room.

m. Lighting and Electric Service Outlets - 30-kva, 3Ø, 208/120 volts.

SP-96-D

APPROVAL

LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
SATURN V ELECTRICAL GROUND SUPPORT
EQUIPMENT FOR LAUNCH COMPLEX 39

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